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OPERATION AND MAINTENANCE POOLS 24, 25, AND 26 MISSISSIPPI AND --ETC(U)
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FINAL

ENVIRONMENTAL STATEMENT

OPERATION AND MAINTENANCE
POOLS 24, 25, AND 26
MISSISSIPPI AND ILLINOIS RIVERS

PREPARED BY

U. S. ARMY ENGINEER DISTRICT
ST. LOUIS. MISSOURI

SEPTEMBER 1975

SECURITY CLASSIFICATION OF THIS PAGE (*When Data Entered*)

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18. SUPPLEMENTARY NOTES

19. KEY WORDS (*Continue on reverse side if necessary and identify by block number*)

20. ABSTRACT (*Continue on reverse side if necessary and identify by block number*)

The 9-foot channel project on the Mississippi River from the mouth of the Missouri River upstream to Minneapolis was first authorized in 1930 and provided for a navigation channel having a 9-foot minimum depth and a maximum width of 300 feet. Locks and dams at Alton, Illinois, Winfield, and Clarksville, Missouri are the primary means of providing the minimum depth within the St. Louis District. Maintenance dredging, dikes, and bankline revetments help maintain the 9-foot channel.

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

SECURITY CLASSIFICATION OF THIS PAGE (*When Data Entered*)

FINAL

ENVIRONMENTAL STATEMENT

OPERATION AND MAINTENANCE
POOLS 24, 25 and 26
MISSISSIPPI AND ILLINOIS RIVERS

Prepared by

U.S. ARMY ENGINEER DISTRICT
St. Louis, Missouri
September 1975

Pages 216 and E-73 are not missing
but misnumbered

SUMMARY SHEET

OPERATION AND MAINTENANCE
POOLS 24, 25 and 26
MISSISSIPPI AND ILLINOIS RIVERS

( ) Draft (X) Final *Environmental Statement*

Responsible Office: U. S. Army Engineer District, 210 North 12th Street. St. Louis, Missouri 63101 Phone: (314) 268-2822

1. Name of Action: (X) Administrative ( ) Legislative

2. Description of the Action: The 9-foot channel project on the Mississippi River from the mouth of the Missouri River upstream to Minneapolis was first authorized in 1930 and provided for a navigation channel having a 9-foot minimum depth and a minimum width of 300 feet. Locks and dams at Alton, Illinois, Winfield and Clarksville, Missouri are the primary means of providing the minimum depth within the St. Louis District. Maintenance dredging, dikes, and bankline revetments help maintain the 9-foot channel.

3.a. Environmental Impacts: The operation and maintenance of the 9-foot channel project involves pool regulation, dredging and placement of dredge material, and maintenance of dikes and revetments.

The direct impacts associated with pool regulation are as follows: stability of water levels; reduced current velocity causing changes in aggradation and degradation patterns in the pooled reach; loss of sediment load causing water in pooled reach to be clearer than in an uncontrolled condition and increased light penetration causes a general increase in primary productivity (yield) in the pools; loss of terrestrial habitat through permanent inundation but a gain in marshland development due to the stability of the pools.

Dredging and dredge material placement results in increased turbidity in the vicinity of the activity. This turbidity may also alter water quality through the resuspension of nutrients, metals and other materials and chemical constituents that may be contained in the sediments. The effect of the resuspension of these materials are expected to be minimal because of the relatively unpolluted nature of the sediment. Placement of dredge material results in destruction of benthic organisms and when on land, smothering of plants and animals and displacement of some animals.

Dikes and revetments have a significant effect on the geomorphic and hydraulic characteristics of the river and prevent "natural" lateral movements from occurring and have a detrimental effect on terrestrial organisms.

b. Adverse Environmental Impacts: The stable pools and the dam structures result in the loss of some aquatic river species and a loss of terrestrial habitat. Dredging and dredge material placement cause the resuspension of contaminants that may be contained in the sediment; also, a loss of benthic organisms and, when on land, smothering of plants and animals. The dikes and revetments affect the geomorphology of the river and prevent "natural" changes from occurring and have a detrimental effect on terrestrial organisms.

4. Alternatives: The following alternatives are addressed: no action, cease all operation and maintenance, and modify pool operation. Also, alternative methods of dredge material placement are discussed:

a. Open water placement, selective placement.

b. Thalweg placement

c. Recreational potential.

d. Stockpiling dredge material.

e. Overbank placement.

f. Riverbasin sediment control.

g. Removal from the flood plain.

5. Comments Received:

Environmental Protection Agency
Advisory Council on Historic Preservation
U.S. Forest Service
U.S. Soil Conservation Service
U.S. Department of Housing and Urban Development
U.S. Department of the Interior
U.S. Department of Transportation
U.S. Federal Power Commission
U.S. Department of Health, Education, and Welfare
Illinois Archaeological Survey
Illinois Department of Conservation
Illinois State Geological Survey
Missouri State Office of Administration (State Clearing House)
    Missouri Department of Conservation
    Missouri Department of Natural Resources
Southern Illinois University-Carbondale, Illinois, Cooperative Wildlife Research Laboratory
University of Missouri - Columbia, Missouri Archaeological Survey
City of St. Louis, Water Division
Union Electric Company
The Ohic River Company
Wisconsin Barge Line
American Fishery Society, Missouri Chapter
Migratory Waterfowl Hunters, Inc.
Sierra Club, Piasa Palisades Group
Waterways Journal

6. Draft statement to CEQ 13 June 1975.

Final statement to CEQ ______________.

ENVIRONMENTAL STATEMENT

POOLS 24, 25, AND 26 - MISSISSIPPI AND ILLINOIS RIVERS
OPERATION AND MAINTENANCE

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PREFACE

The environmental impact statement on the Upper Mississippi and Lower Illinois Rivers (Operation and Maintenance) has been prepared in accordance with Section 102 of the National Environmental Policy Act of 1969 and the existing regulations and guidelines of the Corps of Engineers and the Council on Environmental Quality.

A large portion of the information presented in this document is based on studies specifically conducted for the St. Louis District (SLD) Corps of Engineers by the Office for Environmental Studies, U. S. Army Engineer Waterways Experiment Station (WES) Vicksburg, Mississippi.

WES and SLD formed an interdisciplinary study team of investigators from the Office of Environmental Studies (WES); Department of Earth Sciences and Planning, Southern Illinois University - Edwardsville; Engineering Research Center, Colorado State University; Cooperative Wildlife Research Laboratory, Southern Illinois University - Carbondale; Illinois Natural History Survey; Missouri Botanical Gardens; staff of the SLD. Members of the team examined specific aspects of the study area within their respective areas of expertise and WES was responsible for organizing meetings and general flow of information between units of the team for the interdisciplinary effort.

The following documents provided the baseline data:

Waterways Experiment Station, Contract Report Y-75-1, "Environmental Inventory and Assessment of Navigation Pools 24, 25 and 26, Upper Mississippi and Lower Illinois Rivers, a Vegetational Study", by Missouri Botanical Garden, April, 1975.

Waterways Experiment Station, Contract Report Y-75-2, "Environmental Inventory and Assessment of Navigation Pools 24, 25 and 26, Upper Mississippi and Lower Illinois Rivers, Floodplain Animals and their Habitats", by Cooperative Wildlife Research Laboratory, S.I.U.-Carbondale, April, 1975.

Waterways Experiment Station Contract Report Y-75-3, "Environmental Inventory and Assessment of Navigation Pools 24, 25 and 26, Upper Mississippi and Lower Illinois Rivers, A Geomorphic Study", by Colorado State University, July 1975.

As of June 1, 1975 the following WES reports are in draft form.

"An Environmental Inventory and Assessment of Navigation Pools 24, 25 and 26, Upper Mississippi and Lower Illinois Rivers:

A. "An Aquatic Analysis" - WES
B. "An Electrofishing survey of the Illinois River" - Illinois Natural History Survey
C. "A Summary Report" - WES

Other studies sponsored by the St. Louis District which provided additional data are as follows:

Loadhold, Boyd, 1975. Statistical computer analysis of aquatic data from prior studies of Pools 24, 25, 26 and Mississippi River from St. Louis, Missouri to Cairo, Illinois. Medical University of South Carolina. Charleston, South Carolina.

Waterways Experiment Station, Contract Report Y-74-1, "Evaluation of Three Side Channels and the Main Channel Border of the Middle Mississippi River as Fish Habitat," by Missouri Department of Conservation. March, 1974.

Waterways Experiment Station, Contract Report Y-74-2, "Geomorphology of the Middle Mississippi River" by Colorado State University. July, 1974.

Waterways Experiment Station, Contract Report Y-74-3, "A Survey of the Fauna and Flora Occurring in the Mississippi River Floodplain Between St. Louis, Missouri, and Cairo, Illinois," by Southern Illinois University at Carbondale. August, 1974.

Waterways Experiment Station, Contract Report Y-74-4, "Study of Importance of Backwater Chutes to a Riverine Fishery," by Southern Illinois University at Carbondale, August, 1974

Waterways Experiment Station, Technical Report M-74-5, "Computer-Calculated Geometric Characteristics of Middle-Mississippi River Side Channels, "Volumes I and II, June, 1974.

Waterways Experimental Station, "Physical, Biological, and Chemical Inventory of Twenty-Three Side Channels and Four River Border Areas, Middle Mississippi River," 1974.

Waterways Experiment Station, "Inventory of Physical and Cultural Elements, Middle Mississippi River Flood Plain (River Reach: St. Louis, Missouri, to Cairo, Illinois," January, 1975).

Waterways Experiment Station, Technical Report Y-74-1, "Environmental Analysis and Assessment of the Mississippi River 9-Foot Channel Project Between St. Louis, Missouri, and Cairo, Illinois," November, 1974.

PART 1

1. PROJECT DESCRIPTION

1.1 LOCATION

The 9-foot channel project on the Mississippi River from the mouth of the Missouri River upstream to Minneapolis, Minnesota, was authorized in 1930 and provided for a navigation channel having a 9-foot minimum depth and minimum width of 300 feet. Under this authority the navigation channel is principally provided by a series of low head dams with locks, and is supplemented by maintenance dredging in the channel, and by dikes and bankline revetments. Locks and dams at Alton, Illinois, Winfield and Clarksville, Missouri, (Pools No. 26, 25, and 24) create pooled conditions on 98.3 miles of the Mississippi River within the St. Louis District (Figure 1-1) from Alton, Illinois, upstream to near Saverton, Missouri. In addition, the Locks and Dam at Alton, Illinois, create a pooled condition on the lower 80 miles of the Illinois River.

1.2 PRE-LOCK AND DAM NAVIGATION HISTORY

In its natural state, before man effected changes to the Mississippi River between Alton, Illinois, and Saverton, Missouri, the river was wide and generally shallow. Islands divided the river in numerous localities and emergent sandbars created a further division of the channel during periods of low flow. An example of the difficulty of navigation during this era can be attested to by Pilot J. H. Baldwin, who stated that after the river had fallen to bankfull stage after the flood of 1844, he found it difficult to chart a navigable channel.

To compound the problem of numerous shoals and a torturous navigation channel, the wooden-hull boats were often damaged by submerged, fallen trees (snags) lying just below the water surface and having one end partially embedded in the river bottom. Such trees fell from the caving, non-protected banklines eroded by the natural meandering processes of the river.

The earliest Federal involvement which authorized actual expenditures for the improvement of navigation on the Mississippi River began with a Congressional act on 29 May 1824, which appropriated $75,000 for the removal of snags and sandbars, and to close off slough and backwater areas, i.e., side channels behind islands, to confine flows to the main channel.

1.2.1 FOUR AND ONE-HALF FOOT CHANNEL PROJECT

Such periodic remedial work was undertaken until 1878

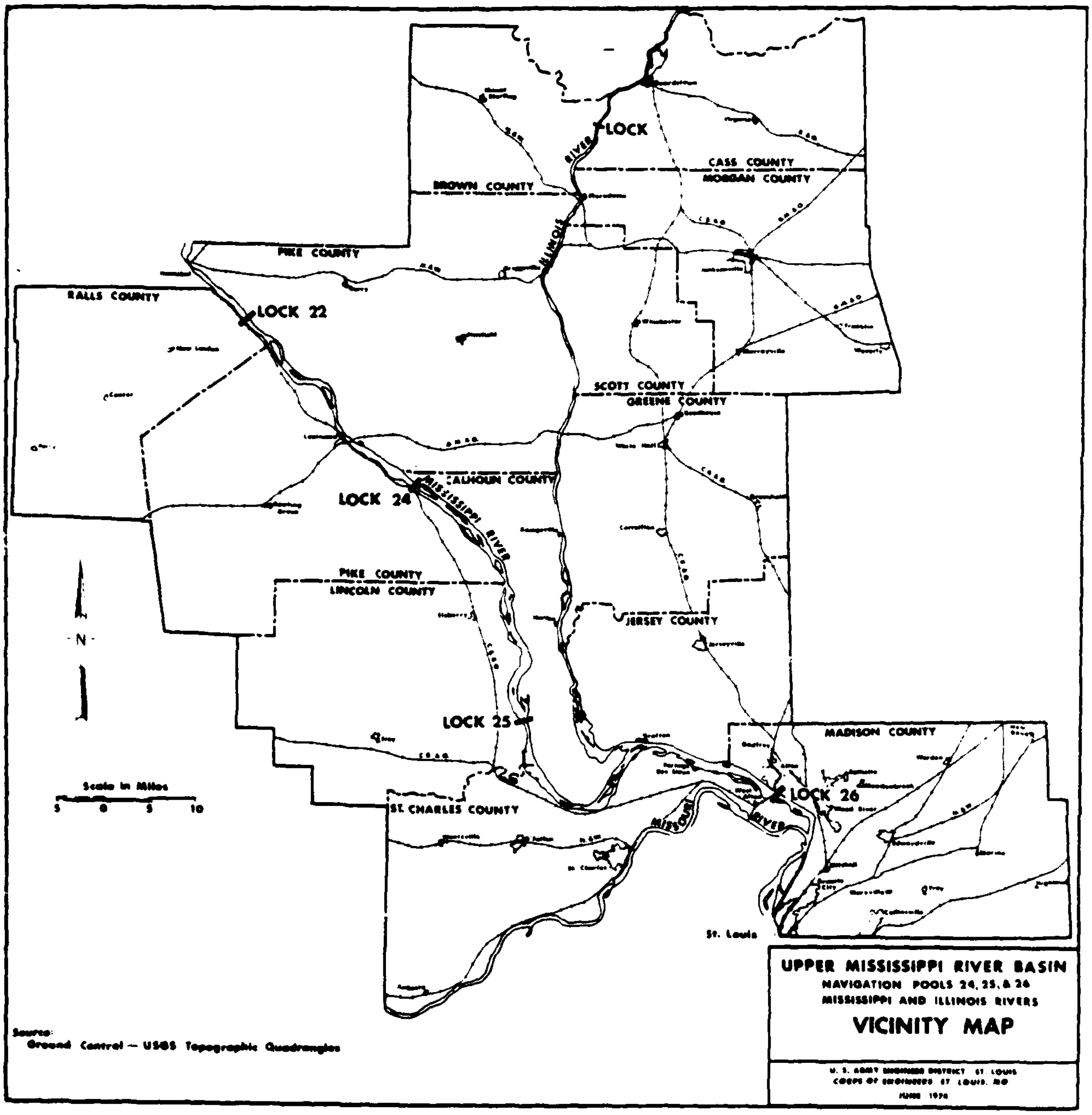

LOCK
CASS COUNTY
MORGAN COUNTY
BROWN COUNTY
ILLINOIS RIVER
PIKE COUNTY
RALLS COUNTY
LOCK 22
SCOTT COUNTY
GREENE COUNTY
LOCK 24
MISSISSIPPI RIVER
PIKE COUNTY
LINCOLN COUNTY
JERSEY COUNTY
N
LOCK 25
Scale in Miles
5 0 5 10
MADISON COUNTY
LOCK 26
ST. CHARLES COUNTY
MISSOURI RIVER
St. Louis
UPPER MISSISSIPPI RIVER BASIN
NAVIGATION POOLS 24, 25, & 26
MISSISSIPPI AND ILLINOIS RIVERS
VICINITY MAP
Source:
Ground Control — USGS Topographic Quadrangles

Figure 1-1

when a 4 1/2-foot channel was authorized for the upper Mississippi River. This systematic work consisted of the construction of willow-rock dikes (also called groins, wing dams, jetties, etc.), bankline revetments, chute closures (closing dams), and the dredging of troublesome channel crossings.

The dikes were made of wood and stone and their purpose was to confine the flows to the main channel and increase stream velocities within the contracted reach, thereby increasing the stream's sediment transport capacity, thus deepening the navigation channel by the resultant river bed scour. The resultant sandbars between adjacent dikes soon became vegetated, with subsequent inundations depositing layers of finer-grained sediments such as silts and clays upon them.

The shoaling patterns between dikes frequently resulted in a side channel behind these newly-formed islands. Such side channels, including the many naturally-formed side channels, are reported to be valuable fish and wildlife habitat areas. In time, the natural processes of the river can result in their loss via siltation, as sediment-laden waters are brought in from the main channel. Many islands eventually became part of the floodplain and were subsequently cultivated.

The construction of chute closures to close off the natural side channels during periods of low flow were effective in diverting low flows to the main channel.

To alleviate the increased scouring action on the opposite bank due to the confinement of flows, the river bank was usually protected with woven wooden mats placed against the bank and sunk with stone. Stabilization of the river banks reduced the amount of lateral channel migration, thus preventing the formation of new side channels.

1.2.2 SIX-FOOT CHANNEL PROJECT

Work continued on the 4 1/2-foot channel project for about 30 years since its beginning in 1878 until increasing demands for a deeper navigation channel brought about the authorization of the 6-foot channel project in 1907. The same methods were used to obtain adequate navigation depths as those for the 4 1/2-foot channel project previously described, with the exception that the contraction width, i.e., spacing between dikes, was narrowed, and greater depths were dredged.

1.3 NINE-FOOT CHANNEL PROJECT

By 1925, it was determined that it would not be possible

to obtain a 6-foot channel throughout the entire reach of the river using the existing channel contraction methods. The River and Harbor Act, dated January 21, 1927, authorized a study of the "Mississippi River between the Missouri River and Minneapolis, with a view to securing channel depths of 9-feet at low water, with suitable widths." Resulting studies by a special board of officers between May 29, 1929, and December 1, 1930, recommended the initial construction of 24 locks and dams between Alton, Illinois, and Minneapolis, Minnesota. Congress authorized the project on 3 July 1930 (House Document 290, 71st Congress, 2nd Session) and construction work officially began within the St. Louis District on 13 January 1934.

1.3.1 NAVIGATION POOLS NO. 24, 25, and 26

Locks and Dams No. 24, 25, and 26 at Clarksville, Missouri, Winfield, Missouri, and Alton, Illinois, respectively, are a part of the 9-foot navigation project on the upper Mississippi River between the mouth of the Missouri River and Minneapolis, Minnesota, which now contain a total of 28 locks and dams (Figure 1-2). The purpose of the series of dams is to create semi-slack water pools for navigation during periods of low and medium flows. The purpose of the locks is to pass river traffic vertically from one pool level to another. When the inflow is sufficient to sustain navigation without the dams, the gates of the dams are lifted out of the water and the river reverts to natural stream flow conditions. The dam structures were constructed as single purpose navigation structures and thus were designed and built to have little or no control or effect on flood flows.

1.3.1.1 NAVIGATION POOL 24

Initial work began on Lock and Dam No. 24 on 20 Jul-1936 (river mile 273.4 above the mouth of the Ohio River) on the Mississippi River at Clarksville, Missouri. Pool 24, which is created by Lock and Dam No. 24, extends northward for 27.8 miles up to Lock and Dam No. 22, near Saverton, Missouri (Figure 1-3) and has a water surface area of approximately 13,000 acres.

The dam consists of 15 movable tainter gates each 80 feet in length and 25 feet high. The control structure has a total length of 1,340 feet. A 2,820.4 foot earth dike with an elevation of 449.0 feet m.s.l. comprises the remaining portion of the dam. Normal pool elevation ranges from 445.5 to 449 feet m.s.l., and the lower gate sills are at elevation 424.0 feet m.s.l. Dam 24 is not intended to act as a flood control structure and the gates may be lifted out of the water during times of high water.

The main lock is 600 feet long by 110 feet wide, and

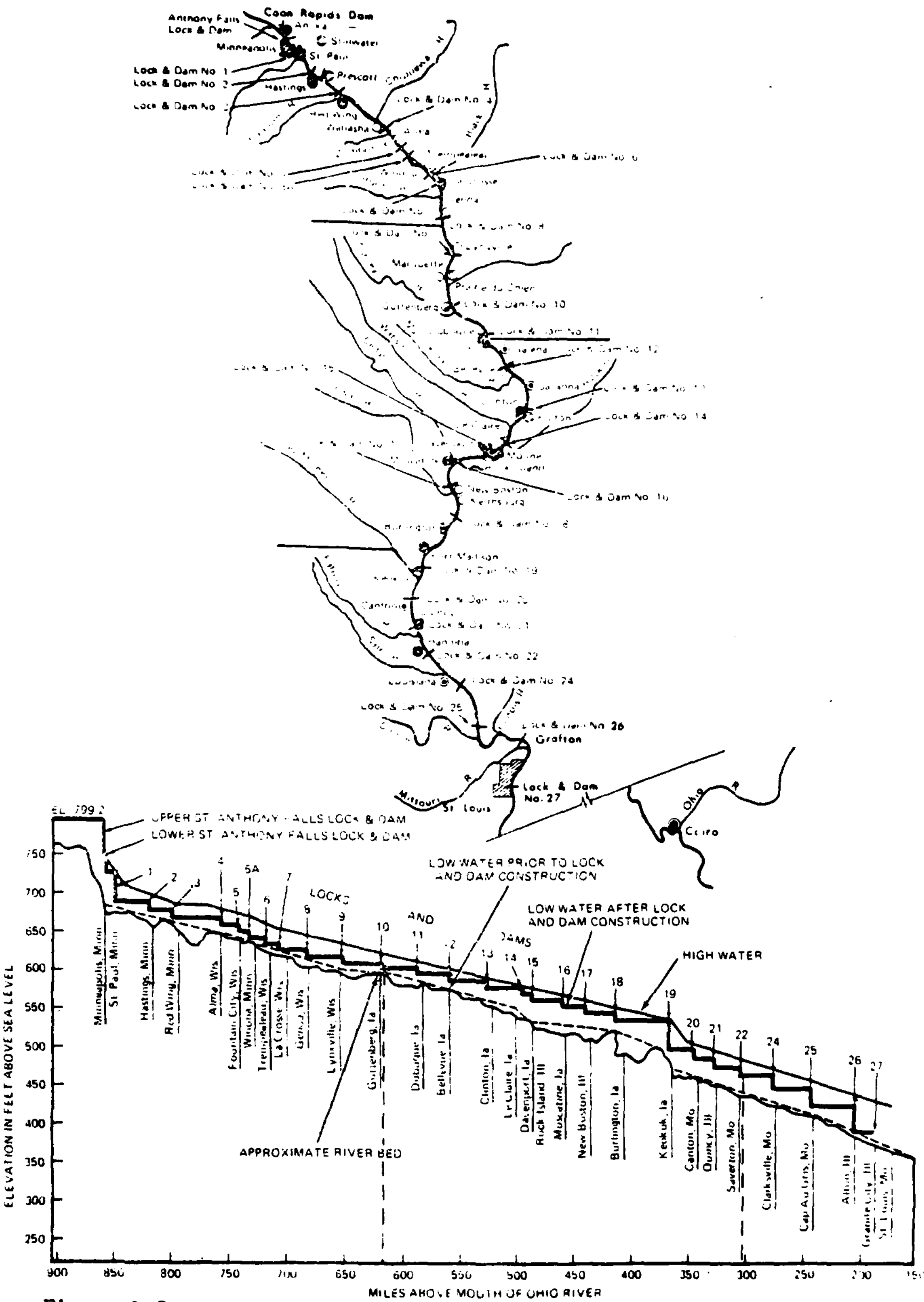


Figure 1-2

Upper Mississippi River -- Mile 0 to 858

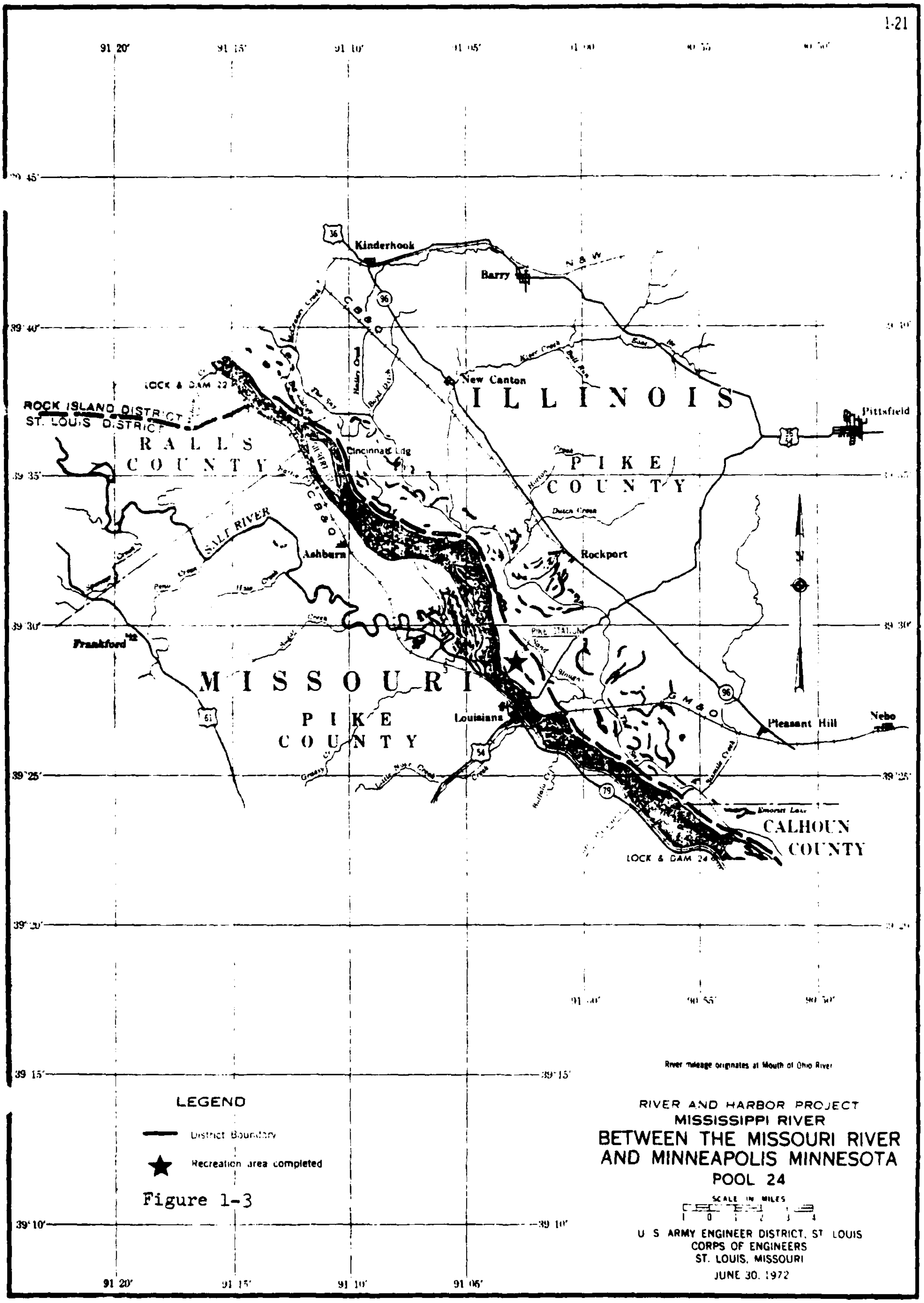

1-21
Kinderhook
Barry
N & W
New Canton
ILLINOIS
Pittsfield
LOCK & DAM 22
ROCK ISLAND DISTRICT
ST. LOUIS DISTRICT
RALLS COUNTY
Cincinnati Ldg
PIKE COUNTY
SALT RIVER
Ashburn
Rockport
Frankford
MISSOURI
PIKE COUNTY
Louisiana
Pleasant Hill
Nebo
CALHOUN COUNTY
LOCK & DAM 24
River mileage originates at Mouth of Ohio River
LEGEND
District Boundary
Recreation area completed
RIVER AND HARBOR PROJECT
MISSISSIPPI RIVER
BETWEEN THE MISSOURI RIVER
AND MINNEAPOLIS MINNESOTA
POOL 24
SCALE IN MILES
U. S. ARMY ENGINEER DISTRICT, ST. LOUIS
CORPS OF ENGINEERS
ST. LOUIS, MISSOURI
JUNE 30, 1972

Figure 1-3

provision was made for a 360-by 110-foot auxiliary lock in the future if deemed necessary. The lock and dam was placed into operation on 12 March 1940 and full (normal) pool was first reached on 14 May 1940. Cost of the project was $6,817,900.

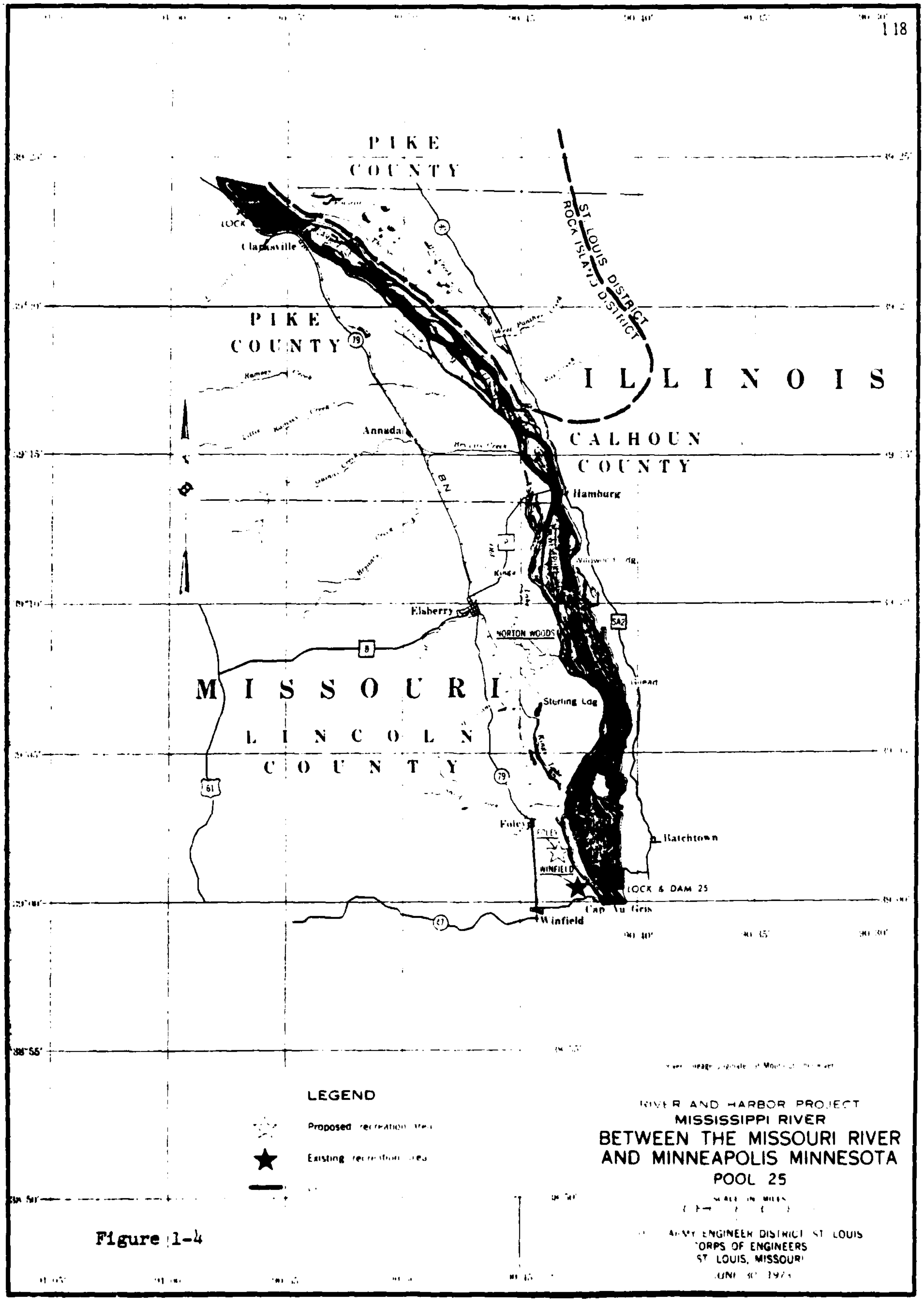
The drainage area of Pool 24 is approximately 140,000 square miles, including about 3,000 square miles of tributary and adjacent hillslope drainage downstream of Lock and Dam No. 22. The principal tributary stream within Pool 24 is the Salt River, which empties into the Mississippi River upstream of Louisiana, Missouri, and has a drainage area of approximately 3,000 square miles at its mouth. The discharge at Lock and Dam No. 24 has varied from an estimated maximum of 440,000 c.f.s. in 1851 to a minimum of 6,000 c.f.s. in 1933. The average width of the river in Pool 24 between high banks is 1,900 feet between Lock and Dam No. 22 and river mile 287, and an average width of 2,300 feet between mile 287 and Lock and Dam No. 24.

Approximately 10,454 acres of land in Pool 24 are owned or controlled by the Government with fee title and flowage easement lands amounting to 9,121 and 1,333 acres, respectively. It is estimated that approximately 4,500 acres of the 9,121 acres of Government fee ownership lands, lie above the established pool elevation of 449.0 feet m.s.l. Of this total fee ownership, approximately 8,151 acres are jointly administered, under the provisions of the General Plan and Co-operative Agreement, by the United States Fish and Wildlife Service and the conservation departments of the states of Illinois and Missouri.

There are 42 miles of Government-owned river shoreline not including shorelines of river islands, sloughs or connecting lakes. A substantial acreage of wildlife habitat, scenic bluffs, and river islands furnish a diversity of recreational opportunities. There are five improved public access points located along the shoreline. Three parks and recreation leases have been granted to the State of Illinois. The largest of these areas is located at Pike Station which is dredged at this location and the dredge material was deposited and leveled to form a location for a marina development. This public use area is operated by the State of Illinois through a concessionaire. In 1972, the reported total visitor-day attendance on this pool was 406,800, and the peak-day attendance was estimated to be 10,000 users.

1.3.1.2 NAVIGATION POOL 25

Initial work began on Lock and Dam No. 25 on 12 November 1935 (Mississippi River mile 241.4) near Winfield, Missouri. Pool 25, which is created by Lock and Dam No. 25, extends northward



PIKE COUNTY
ST. LOUIS DISTRICT
ROCK ISLAND DISTRICT
LOCK
Clarksville
PIKE COUNTY
ILLINOIS
Annada
CALHOUN COUNTY
Hamburg
Elsberry
NORTON WOODS
MISSOURI
LINCOLN COUNTY
Sterling Ldg
Foley
Batchtown
WINFIELD
LOCK & DAM 25
Cap Au Gris
Winfield
LEGEND
Proposed recreation area
Existing recreation area
RIVER AND HARBOR PROJECT
MISSISSIPPI RIVER
BETWEEN THE MISSOURI RIVER
AND MINNEAPOLIS MINNESOTA
POOL 25
SCALE IN MILES
ARMY ENGINEER DISTRICT ST. LOUIS
CORPS OF ENGINEERS
ST. LOUIS, MISSOURI

Figure 1-4

for 32 miles to Lock and Dam No. 24 at Clarksville, Missouri (Figure 1-4), and has a water surface area of approximately 19,000 acres.

The dam consists of 14 movable tainter gates (each 60 feet long by 25 feet high) and three roller gates (each 100 feet long by 25 feet high). The total length of the control structure is 1,296 feet. A 2,566-foot long earth dike with an elevation of 434.5 feet m.s.l. comprises the remaining portion of the dam. Normal pool elevation is a minimum of 429.7 to a maximum of 434 feet m.s.l., and the lower gate sills are at an elevation of 409.0 feet m.s.l.

The main lock is 600 feet long by 110 feet wide, and provision was made for a 360-by110-foot auxiliary lock in the future, if deemed necessary. Lock and Dam No. 25 was placed into operation on 18 May 1939 and full (normal) pool was first reached on 11 July 1939. Cost of the project was $8,[illegible]87,600.

The drainage area of Pool 25 is approximately 142,000 square miles including about 1,000 square miles of tributary and adjacent hillslope drainage. The principal tributary stream within Pool 25 is the Sny, which empties into the Mississippi River at river mile 260.9, and has a drainage area in Illinois of approximately 750 square miles at its mouth. The average width of the river between banks in Pool 25 is about 1,800 feet with about 1,300 feet in the reach between Lock and Dam No. 24 and mile 254, and 2,500 feet from mile 254 downstream to Lock and Dam 25.

Approximately 11,039 acres of land in Pool 25 are owned or controlled by the Government with fee title and flowage easement lands amounting to 10,092 and 947 acres, respectively. It is estimated that approximately 5,100 acres of the 10,092 acres of Government fee ownership lands, lie above the established pool elevation of 434 feet m.s.l. Of this total fee ownership, approximately 8,515 acres are jointly administered under the provisions of the General Plan and Cooperative Agreement, by the United States Fish and Wildlife Service and the conservation departments of the states of Illinois and Missouri.

Much of the Government-owned land furnishes suitable habitat for wildlife and is suited to a variety of recreational uses. The Corps of Engineers has leased seven recreation service concessions to private operators on this pool. In addition, there are four park and recreation leases - Titus Hollow and Red's Landing in Illinois, and Norton Woods and American Legion in Missouri. During 1972, the reported total visitor-day attendance on this pool was 867,850 and the peak-day attendance was estimated to be 18,000 users.

1.3.1.3 Navigation Pool 26

Initial work began on Locks and Dam No. 26 on 13 January 1934 at Mississippi River mile 202.9 at Alton, Illinois. Pool 26, which is created by Locks and Dam No. 26, extends northward for 38.5 miles up the Mississippi River, and for 80 miles up the Illinois River (Figures 1-5 and 1-6). The total water surface area is approximately 40,000 acres.

The dam consists of 30 movable tainter gates (each 40 feet long by 30 feet high) and three roller gates (each 80 feet long by 25 feet high), thus giving the control structure a total length of 1,725 feet. The normal regulated pool elevation ranges from 414 to 419 feet m.s.l., and the lower gate sills are at elevation 389.0 feet m.s.l.

The main lock is 600 feet long by 110 feet wide and the auxiliary lock is 360 feet long by 110 feet wide. Locks and Dam No 26 were placed into operation on 1 May 1938 and normal (maximum regulated) pool was first reached on 8 August 1938. Cost of the project was $13,119,500.

The drainage area of Pool 26 is approximately 171,600 square miles, including about 29,000 square miles for the Illinois River which enters the Mississippi River at Grafton, Illinois. A secondary tributary of the Mississippi River in Pool 26 is the Cuivre River which empties into the Mississippi River at mile 236.8 and has a drainage area in Missouri of approximately 1,230 square miles. Macoupin Creek, with a drainage area of approximately 970 square miles, enters the Illinois River at river mile 23, and is the principal tributary of the Illinois River in Pool 26. The discharge at the Locks and Dam No. 26 site has varied from a maximum of 573,000 c.f.s. in 1858 (prior to Locks and Dam No. 26 construction), to a minimum recorded discharge of 7,960 c.f.s. in 1948. The average width of the Mississippi River in Pool 26 is 1,900 feet between Lock and Dam No. 25 and mile 222, and 2,700 feet between mile 222 and Locks and Dam No. 26. The average width of the Illinois River in Pool 26 is approximately 1,100 feet.

Approximately 26,558 acres of land in Pool 26 are owned or controlled by the Government, with fee title and flowage easement lands amounting to 22,238 and 4,320 acres, respectively. It is estimated that approximately 11,100 acres of the 22,238 acres of Government fee ownership lands, lie above the established pool elevation of 419.0 m.s.l. Of this total fee ownership, approximately 19,144 acres are jointly administered, under the provisions of the General Plan and Cooperative Agreement, by the United States Fish and Wildlife Service and the conservation departments of the states of Illinois and Missouri.

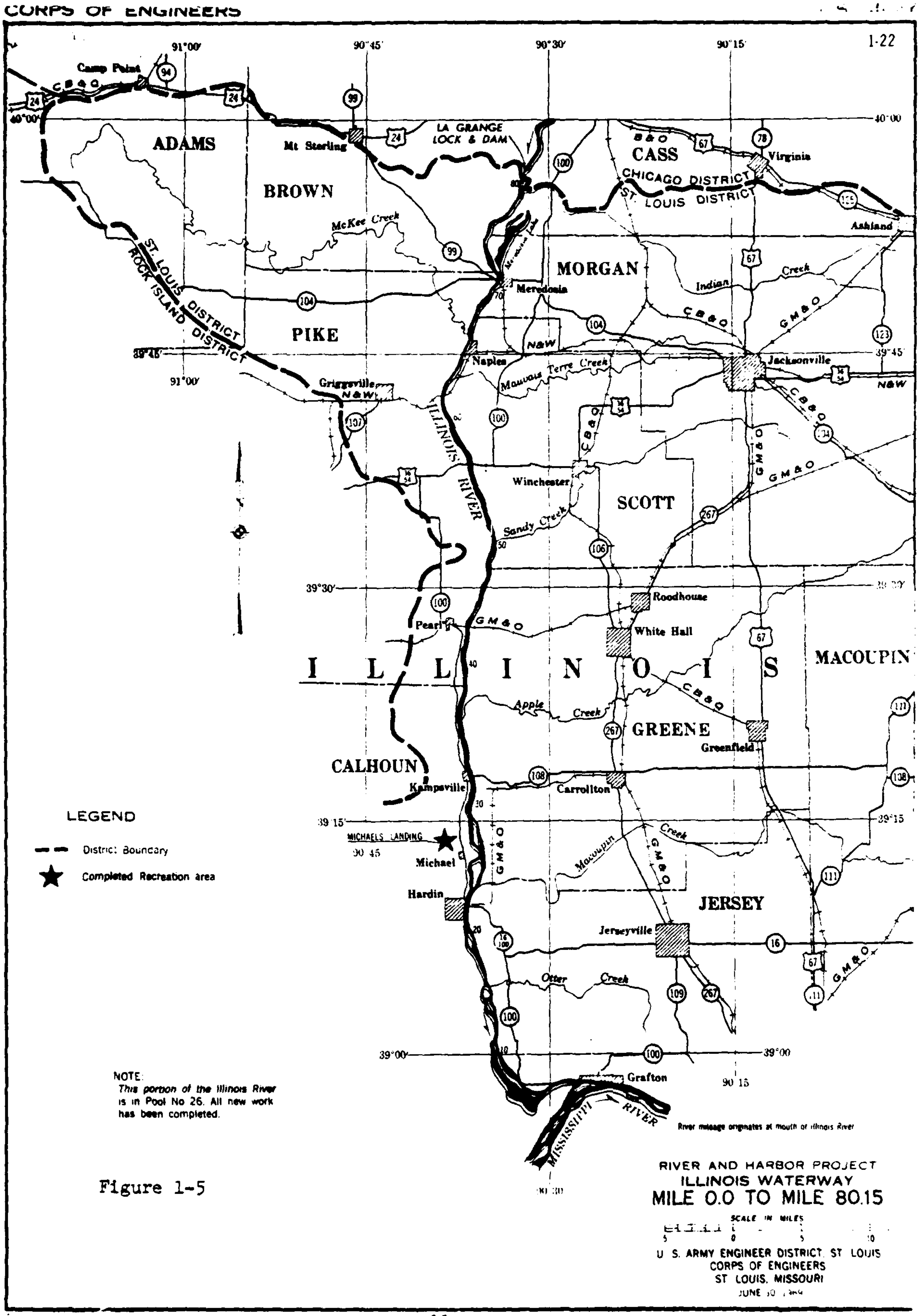

1-22
91°00'
90°45'
90°30'
90°15'
40°00'
39°45'
39°30'
39°15'
39°00'
Camp Point
Mt Sterling
LA GRANGE LOCK & DAM
CASS
Virginia
CHICAGO DISTRICT
ST. LOUIS DISTRICT
Ashland
ADAMS
BROWN
McKee Creek
MORGAN
Meredosia
Indian Creek
ST. LOUIS DISTRICT
ROCK ISLAND DISTRICT
PIKE
Naples
Mauvais Terre Creek
Jacksonville
Griggsville
ILLINOIS RIVER
Winchester
SCOTT
Sandy Creek
Roodhouse
White Hall
Pearl
ILLINOIS
MACOUPIN
Apple Creek
GREENE
Greenfield
CALHOUN
Kampsville
Carrollton
MICHAELS LANDING
Michael
Macoupin Creek
Hardin
JERSEY
Jerseyville
Otter Creek
Grafton
MISSISSIPPI RIVER
LEGEND
District Boundary
Completed Recreation area
NOTE:
This portion of the Illinois River is in Pool No 26. All new work has been completed.
River mileage originates at mouth of Illinois River
RIVER AND HARBOR PROJECT
ILLINOIS WATERWAY
MILE 0.0 TO MILE 80.15
SCALE IN MILES
U. S. ARMY ENGINEER DISTRICT, ST. LOUIS
CORPS OF ENGINEERS
ST. LOUIS, MISSOURI

Figure 1-5

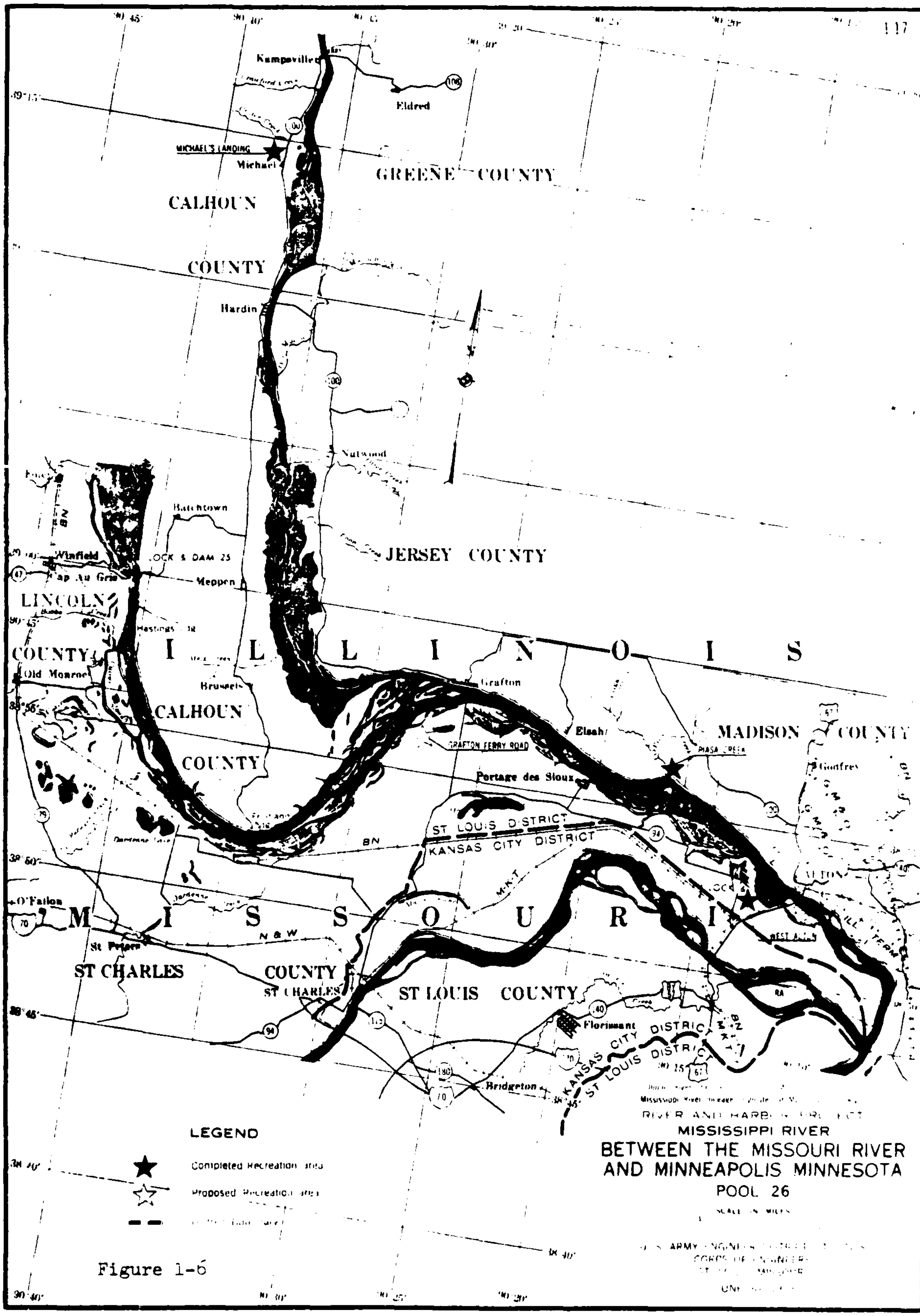

Kampsville
Eldred
MICHAEL'S LANDING
Michael
GREENE COUNTY
CALHOUN
COUNTY
Hardin
Nutwood
Batchtown
Winfield
LOCK & DAM 25
Cap Au Gris
Meppen
LINCOLN
COUNTY
JERSEY COUNTY
I L L I N O I S
Old Monroe
Brussels
Grafton
CALHOUN
COUNTY
GRAFTON FERRY ROAD
Elsah
MADISON COUNTY
PIASA CREEK
Godfrey
Portage des Sioux
ST LOUIS DISTRICT
KANSAS CITY DISTRICT
BN
M-K-T
O'Fallon
M I S S O U R I
N & W
St Peters
ST CHARLES
COUNTY
ST CHARLES
ST LOUIS COUNTY
Florissant
KANSAS CITY DISTRICT
ST LOUIS DISTRICT
Bridgeton
WEST ALTON
LEGEND
Completed Recreation Area
Proposed Recreation Area
MISSISSIPPI RIVER
BETWEEN THE MISSOURI RIVER
AND MINNEAPOLIS MINNESOTA
POOL 26

Figure 1-6

As in the other pools, there is a substantial amount of Government-owned land which is suited for wildlife habitat. and recreational use. The Corps of Engineers has leased eight recreation service concessions to private operators on this pool. There are numerous private marinas as well as eleven park and recreation leases; ten in Illinois and one in Missouri. The Corps of Engineers also has three major public access areas programmed on this pool. One is currently in operation at the Missouri abutment of Locks and Dam 26, at West Alton, Missouri. A second area is located at Michael's Landing above Hardin, Illinois, on the Illinois River. During 1972 the total reported visitor-day attendance on this pool was 2,718,900 and the peak-day attendance was estimated to be 60,000 users.

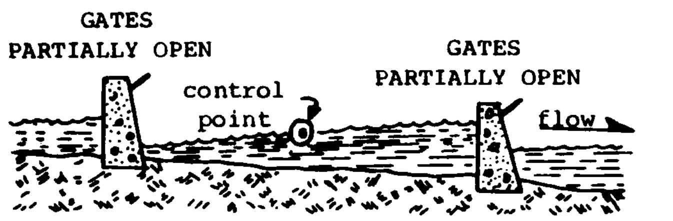
1.3.2 POOL REGULATION - DAMS 24, 25, AND 26

Each dam is operated to fit the river flow conditions that exist. In the normal operation, all gates are partially open with water flowing beneath. As the flow increases or decreases, the gate openings are increased or decreased accordingly. Each pool has a control point, or gauge, about halfway between the lock and dam structures with an established maximum regulated and minimum elevation, or stage, of water level. In order to maintain a 9-foot minimum depth throughout the pool, the water is not allowed to fall below the minimum elevation at the control point, During normal pool stages, the water level behind the dam is nearly level (Figure 1-7a).

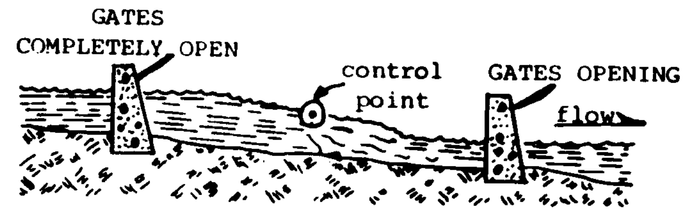
As the discharge increases, the water surface in the upstream portion of the pool rises and the gates of the upstream dam are completely open (Figure 1-7b). The gates of the dam downstream are opened further to pass the increased flow and keep the elevation at the control point within its established limits. By this means, inundation of the lands along the river is held within designated areas. As the gates are opened, the water surface elevation upstream from the dam lowers (drawdown) and the water surface throughout the pool attains a slope (above normal upstream - below normal downstream). At that time, the water surface elevation upstream of the control point is higher than normal and that downstream is lower than normal to accommodate the oncoming high water, and the water surface at the control point remains practically unchanged.

During high water periods, the dams have no control over flooding and open river conditions prevail. At such times, when the stage at the control point is higher than desired, the gates are lifted entirely out of the water and the stages reached are the same as they would have been had the dams not been in existence (Figure 1-7c).

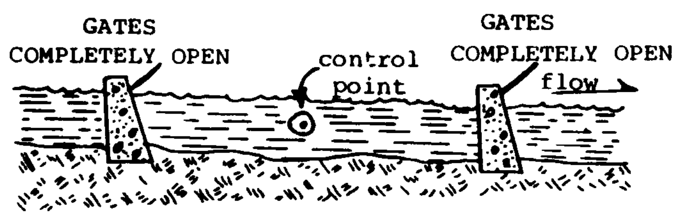
After the high water passes and the flow decreases, it is necessary to reverse the procedure in order to restore the water surface at the control point to its established level.



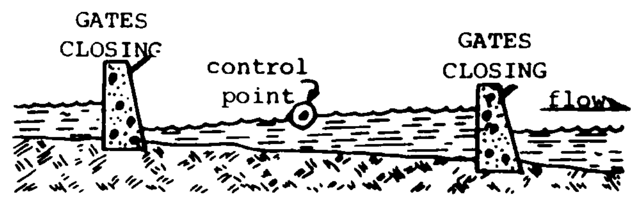
a. NORMAL FLOW PERIOD



b. INCREASING FLOW PERIOD



c. HIGH FLOW PERIOD



d. DECREASING FLOW PERIOD

POOL REGULATION - SCHEMATIC Figure 1-7

That is, the water surface in the upper part of the pool may drop to a point where 9-foot minimum navigation channel depths are threatened. The gates of the downstream dam are then partially closed by placing them in the water and adjusting the openings to maintain the established stage at the control point. In this way, the water level upstream at the dam is slowly raised until the pool reaches its normal level throughout its length (Figure 1-7d).

The St. Louis District maintains contact with other Corps of Engineer Districts upriver so as to properly regulate flows through the dams. For example, if the area under the jurisdiction of the Rock Island, Illinois District has a heavy rainfall, the St. Louis District is informed so that the gate openings may be increased to pass the flow as it arrives downstream at each dam. The operation of Locks and Dam 26 is governed not only by the releases from the upper Mississippi River dams, but also by the inflow from the Illinois River as well as backwater effects from the Missouri River.

1.3.3 REGULATING WORKS - DIKES, BANKLINE REVETMENTS, AND CHUTE CLOSURE

Prior to the construction of Locks and Dams 24, 25, and 26, the portion of the Mississippi River between miles 195.0 and 300.0 which form a part of the waterways under the jurisdiction of the St. Louis District were maintained by regulating works, i.e., dikes and revetments and dredging.

The reach of river from approximate river miles 273 to 300 now controlled by Lock and Dam 24 contains approximately 120,000 lineal feet of revetment and 60 dikes which were designed to maintain the navigation channel under open river conditions prior to the time Lock and Dam 24 was placed in operation. From the time Lock and Dam 24 was placed in operation in 1940 up through 1969 no repairs were made to the existing regulating works in Pool 24. From 1969 to the present time eight (8) out of 60 dikes contained in Pool 24 have been repaired and 99,780 lineal feet of revetment have been repaired.

The reach of river, Mississippi River miles 241 to 273 now controlled by Lock and Dam 25 contains approximately 140,000 lineal feet of revetment and approximately 90 dikes which maintained the navigation channel under open river conditions prior to the time Lock and Dam 25 was placed into operation. Between 1939 and 1969 no repairs were made to regulating structures in Pool 25. Between 1969 and the present time 106,984 lineal feet of revetment repairs have been made and 3 dikes out of the 90 contained in Pool 25 have been repaired.

The reach of river, Mississippi River miles 202 to 241 now controlled by Locks and Dam 26 contains approximately 90,000

lineal feet of revetment and 110 dikes which maintained the navigation channel prior to the time Locks and Dam 26 were placed into operation. Between 1938 and 1969 some minor revetment repairs were made in Pool 26. Between 1969 and the present time 65,908 lineal feet of revetment have been repaired and no repair work has been performed on over 100 dikes contained in Pool 26.

As can be seen from the foregoing discussion the major effort under the maintenance program for regulating works has been confined to the repair of existing revetment works contained in Pools 24, 25, and 26. All of the revetment repairs have been made upstream of the Illinois River which enter the Mississippi River at approximate mile 218. During the winter season the Mississippi River above mile 218 is generally frozen over with ice.

From the times Locks and Dams 24, 25, and 26 were placed in operation to 1968, heavy icepacks severely damaged existing revetment works and in many instances these structures were completely destroyed. Field investigations made in 1968 increased dredging requirements due to increased erosion in the navigation pools at those localities where revetments had been damaged or completely destroyed. Numerous trees were being washed into the river, which contributed to a maintenance problem at the locks and dams because heavy drift was interfering with the operation of the locks. The inspection also indicated that the alinement of the navigation channel could be adversely affected unless immediate action was taken to repair the damaged revetment works.

Under normal circumstances a great deal of bank grading work and timber clearing is required to affect revetment repair. During the joint review process for proposed repair work in the navigation pools conservation agencies expressed their concern over the destruction of many trees which would have to be cut down to make the necessary revetment repairs, and they were also concerned about the disposal of bank grading material. In order to dispose of bank grading material about the high bank, it would first be necessary to clear a large amount for disposal site and conservationists were opposed to that alternative. They were also opposed to the alternative of casting bank grading material into the river. Accordingly, a compromise solution was reached wherein timber clearing would be kept to an absolute minimum, which required that the contractor cast revetment stone on a damaged reveted area through standing timber. In order to overcome the bank grading problem the St. Louis District agreed to construct a number of rock fills to reconstruct revetment which had been completely destroyed in an effort to keep bank grading requirements to an absolute minimum.

It was found that casting stone between standing timber initially caused what appeared to be serious damages to existing

trees along the reveted bankline. After a few years, however, it was noted that very few of these trees were permanently damaged and in many instances it was difficult for the untrained eye to ascertain that the trees had been damaged at all during the construction period. Insofar as the rock fills are concerned, these structures have virtually eliminated the need for bank grading in the navigation pools and these structures have proven themselves to be very satisfactory in maintaining the alinement of the navigation channel and possess a high resistance to preclude further damages from current attack during open river conditions and are also resistant to the attack of heavy ice flows during the winter season.

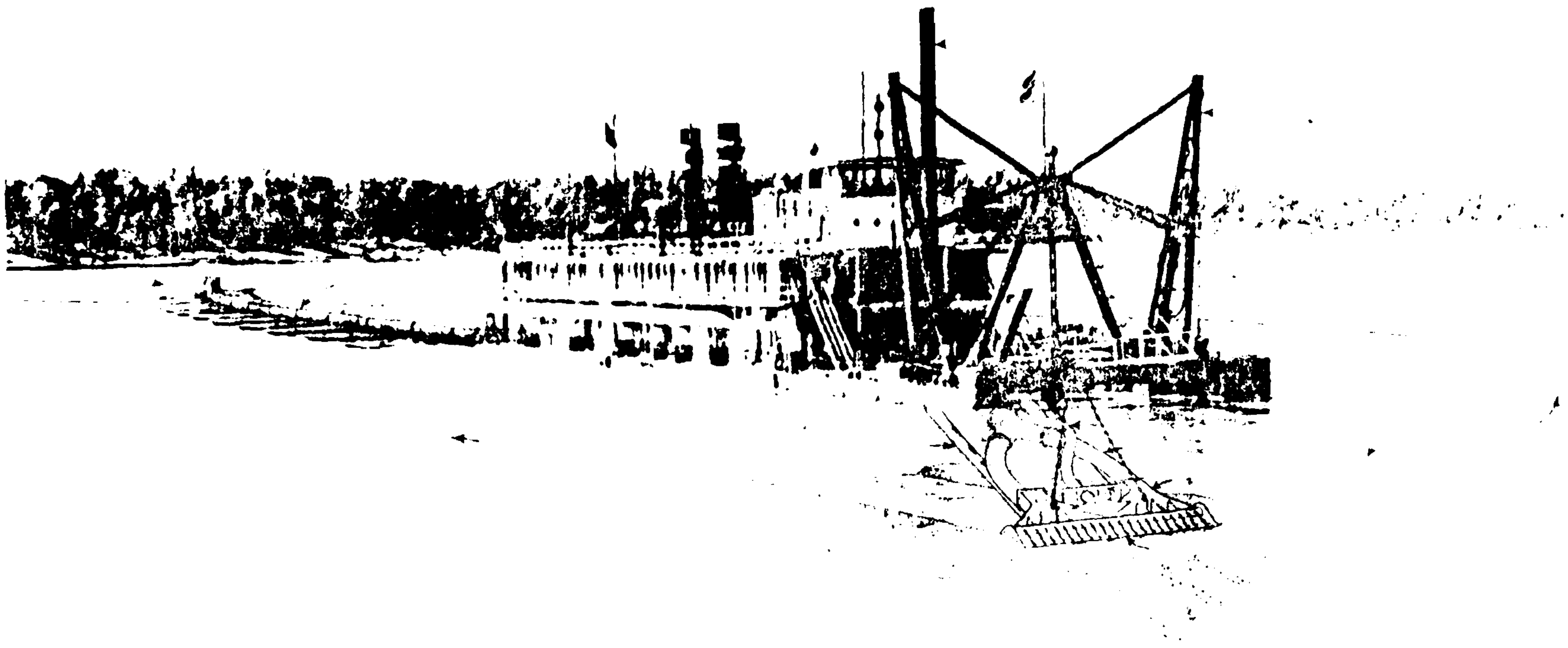
One L-head dike has been constructed immediately upstream of Lock and Dam 25 to improve an outdraft problem in the navigation channel. One spur has been constructed immediately upstream of Lock and Dam 24 to improve an outdraft problem in the navigation channel at that location. Four dikes have been repaired in the vicinity of river mile 298 to ascertain whether or not contraction could be utilized in the navigation pools to reduce dredging requirements at a troublesome channel crossing. Although these dikes have proven that it is possible to reduce dredging requirements, similar dike repair work has not been performed at other localities in an effort to cooperate with concerned conservation agencies pending completion of this environmental statement.

1.3.4 MAINTENANCE DREDGING

Dredging is used to maintain adequate navigation depths within pools 24, 25, and 26. The purpose of a dredge is to remove the sand and silt-size material from the bottom of the navigation channel and deposit it outside of the navigation channel. The St. Louis District presently uses two types of dredges to maintain the navigation channel from Hannibal to St. Louis, Missouri on the Mississippi River and from La Grange to Grafton, Illinois on the Illinois River. They are a dustpan and cutterhead dredge.

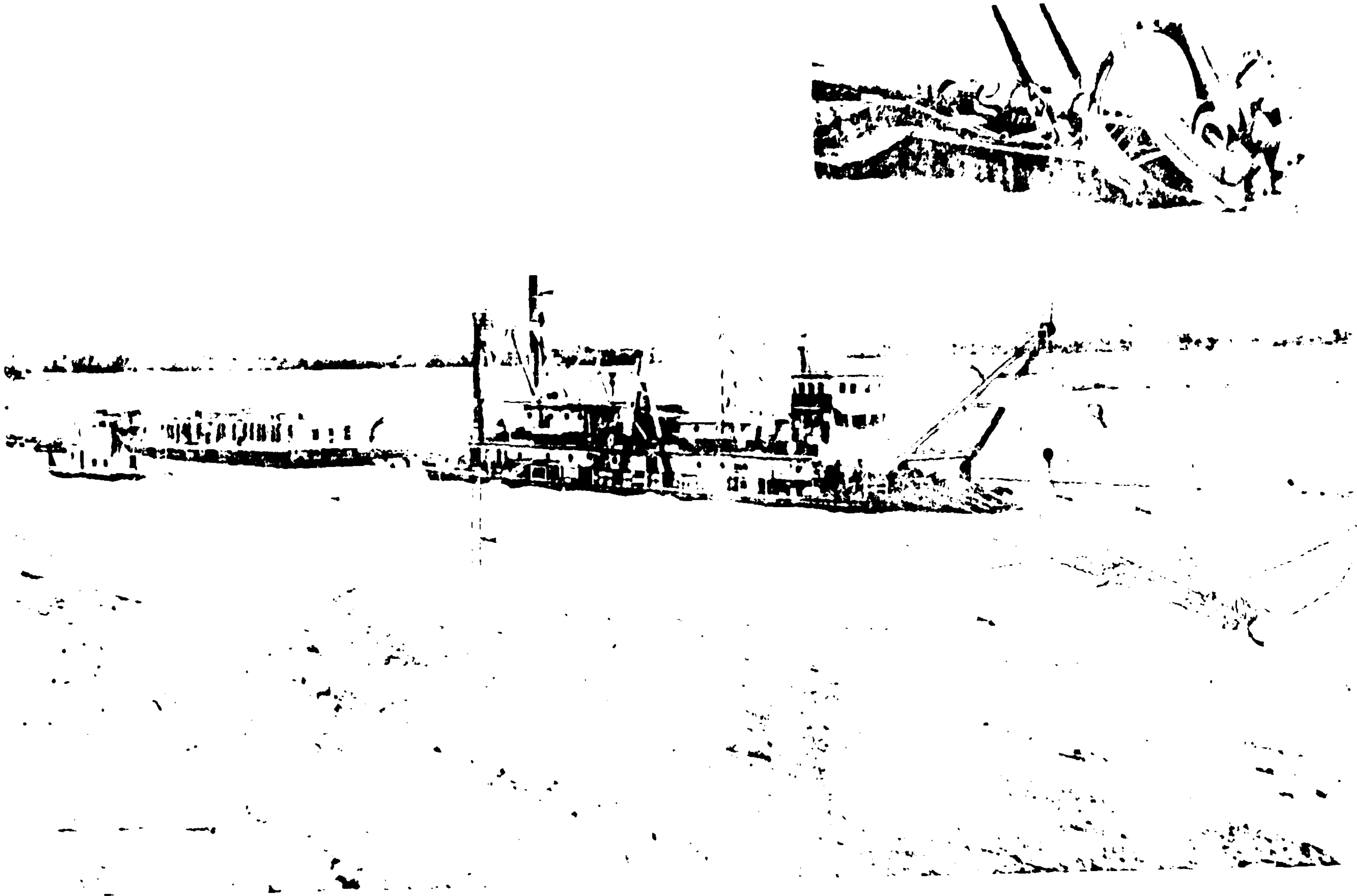
The dredge Kennedy is a dustpan-type dredge (Figure 1-8), which has a 28-foot wide head which moves upstream in a straight line and loosens the sediments in the river bottom with the aid of high-pressure water jets. Immediately behind the water jets, suction intakes are provided which pull in the loosened material and discharges the sediments (dredge material) via a 24-inch diameter floating pipe, generally 850 feet long, outside of the navigation channel boundaries. A series of 28-foot wide parallel cuts are made until the desired clearance is achieved.

The dredge Ste. Genevieve is a cutterhead-type dredge



DUSTPAN DREDGE - DETAIL OF OPERATION

Figure I-8



CUTTERHEAD DREDGE DETAIL OF OPERATION

F[illegible] 9

(Figure 1-9) which consists of a series of revolving circular blades which can cut through coarser and/or more cohesive materials. A suction intake is positioned within the blade assembly which collects the loosened sediments and discharges the material, via a floating pipe up to 3,000 feet in length, outside of the navigation channel. The dredge can make a sweeping motion as it moves upstream, thus being able to make a 300-foot wide cut in a single pass.

Dredging in Pools 24, 25, and 26 in the upper Mississippi River is usually performed with the dredge Kennedy since the bed material is primarily sand sized material. Conversely, dredging on the lower 80 miles of the Illinois River has been performed in the past with the dredge Ste. Genevieve since the bed material contains an appreciable amount of gravel and frequent deposits of cohesive silt and clay-size material, which require more physical force to dislodge. Recently, dredging on the Illinois River has been offered for outside contract.

Although Dams 24, 25, and 26 create pooled semi-slack-water conditions on the upper Mississippi and Illinois Rivers, the basic characteristics of alluvial streams are still present. The streams consist of an alternating series of deep pools and shallow crossings in which the thalweg (main currents) crosses from one side of the river to the other. The dredging localities are usually at the crossings where the sediment transport capacity of the stream is reduced.

To maintain a minimum 9-foot navigation channel, dredge cuts are usually made to a depth of 9-feet below the minimum pool elevation. A two foot over-depth cut is made to provide for any subsequent siltation; thus, reducing the necessity to make frequent, repetitive cuts in the same locality.

Channel maintenance dredging is currently accomplished on an emergency basis. Many of the dredge cut sites are investigated and surveyed for dredging after the site has been identified by a user of the river (commercial tow boats). When a tow boat bumps (hits a high spot in the river bed) the exact location of the bump is reported to the nearest lockmaster and the information is then reported to the Channel Maintenance Section which in turn dispatches the patrolboat Pathfinder to the location for a sounding survey map after which the site is scheduled for dredging.

Annual maintenance dredging in the Mississippi and Illinois Rivers, for the years of record 1965 through 1974, has resulted in the movement of an average of 1.3 million cubic yards and 0.5 million cubic yards of material. Of the total channel length dredged for the 105 miles of the Mississippi and the lower 80 miles

of the Illinois River, an annual average of 6.1% (or 6.4 miles) and 2.9% (or 2.3 miles) of the total channel length was dredged in the Mississippi and Illinois Rivers, respectively. Plates 9A-D, Dredging from 1969 through 1974, indicate dredging location and respective dredge material placement areas.

Future dredging requirements for the Mississippi River, on a 5-year projected basis, indicates approximately 27 locations will need to be dredged at least twice during this time period. Also, the 5-year projected dredging requirements for the Illinois River indicates approximately 12 locations will need to be dredged at least once during this time period. The selection of these locations are based on the previous need to dredge the navigation channel at troublesome crossings. Most projected locations coincide with previous dredge cuts and may be identified as critical reaches because of repetitive dredging activities. Plates 12A-P graphically illustrate the locations of future projected dredging activities on the Mississippi River.

Material from the dredging operations within Pools 24, 25, and 26 on the upper Mississippi River is usually deposited within the river along or near the riverbank, or adjacent to the main navigation channel. Dredge material from Pool 26 on the lower portions of the Illinois River is usually deposited upon the floodplain adjacent to the river during high stages. Coordination is maintained with the proper state and federal agencies regarding the placement of this dredge material. It is felt that the subject of dredge material placement is major issue in this environmental statement and will be addressed further in subsequent sections.

1.4 ECONOMIC SUMMARY

Operation and maintenance charges in Pools 24, 25, and 26 have averaged $4,577,000 annually during the period FY 70 through 74. These charges include operation of the locks and appurtenances plus dikes, revetment, dredging and dredge material handling, when required, to maintain authorized nine-foot navigation depth. Appendix A segregates the above total by activity.

1.5 RELATED STUDIES

1.5.1 LOCKS AND DAM NUMBER 26 (REPLACEMENT)

The existing Locks and Dam No. 26 were placed in operation in May 1938. Tonnage passing through the locks has increased from 1.4 million tons during the first year of operation, to 54 million tons in 1972. and 52.9 million tons in 1974.

The St. Louis District submitted a report in 1968, recommending that the existing structure be replaced with a new facility at a location about two miles downstream. The new facility would consist of two 110-by 1200-foot separated locks, a gated spillway, and an overflow dike on the Missouri side. This report was approved by the Secretary of the Army in 1969.

The replacement project is considered essential due to the inadequate locking capacity and difficulties in maintaining the existing structure. Locks and Dam No. 26 is a vital link in the inland waterway system, carrying year-round waterborne commerce to and from Lower, Middle, and Upper Mississippi River, Ohio, and Illinois Waterway. The existing locks reached their annual practical capacity of 46 million tons of waterborne commerce during 1970. Tows have been experiencing delay times of an average of over five hours on locking through Locks No. 26.

In addition to the inadequate locking capacity, maintenance costs have been excessive over the past few years due to structure movements. In 1970 and 1971, approximately $1,000,000 was spent in emergency rehabilitation to i nsure the structural integrity of the lock structure.

Preconstruction planning funds for the project were released in June 1970. Initiation of construction on this project was approved in the Fiscal Year 1974 Appropriations Bill signed by the President on 16 August 1973. Bids on the first item of construction, the first stage cofferdam, were to be opened on 7 August 1974. However, lawsuits were filed in the U.S. District Court for the District of Columbia on 6 August 1974 by the Izaak Walton League of America, the Sierra Club, and 21 railroads to halt the construction of the replacement project. Following a hearing, the court issued a preliminary injunction on 5 September 1974 preventing any action in furtherance of the project, pending a trial on the merits. It was the written opinion of the court that the "project will be delayed only until the defendants obtain the consent of Congress and cure the defects in the EIS."

A trial was set for 3 March 1975, but has been indefinitely deferred based on letters sent by the Secretary of the Army to the Chairmen of the House and Senate Appropriations and Public works Committees of the Congress, asking for "a reaffirmation or clarification of the authority of the Secretary of the Army prior to proceeding with construction of Locks and Dam 26."

A supplement to the final Environmental Statement is now being prepared in connection with Locks and Dam No. 26 (replacement). An updated economic analysis on the project has been prepared, and a revised report will be submitted along with the Environmental Supplement.

1.5.2 TWELVE-FOOT CHANNEL STUDY

There is an authorized Corps of Engineers study of the feasibility of providing a 12-foot navigation channel on the Mississippi River from the mouth of the Ohio River to Minneapolis, Minnesota, and on the Illinois River from its mouth to the Great Lakes. The Phase I Report on this study indicated that it is not economically feasible to achieve a 12-foot project on the Mississippi River upstream of the Illinois River at this time, but that continued study from the Ohio River to the Illinois River and thence to Chicago is justified. This study was placed in an inactive status and its investigations brought to a halt during the spring of 1975. Although it remains an authorized study, at the present time, no funds are available, and no work is being done on this feasibility study.

1.5.3 MISSISSIPPI RIVER - YEAR ROUND NAVIGATION STUDY

There is an authorized Corps of Engineers study of year round navigation on the Upper Mississippi River. The Phase I Report on this study concluded that the proposals considered for extending the navigation season in the Upper Mississippi River, including that portion of the River covered by this environmental statement, would require more feasibility studies before any recommendations could be made. This stbudy remains authorized although as of 24 November 1975 it is not being funded and no work is being done on it.

1.6 PLANS OF OTHER FEDERAL, STATE, AND LOCAL AGENCIES

1.6.1 FEDERAL AGENCY PLANS

1.6.1.1 U. S. Fish and Wildlife Service

The Mark Twain National Wildlife Refuge, operated

by the U.S. Fish and Wildlife Service, manages six refuge divisions within the project area. The divisions are managed primarily for wildlife habitat enhancement, with other recreational activities, such as wildlife photography and boating access, provided. Portions of the management lands are owned and operated by the U.S. Fish and Wildlife Service, whereas some portions of the management lands (approximately 6,000 acres) are located on 9-foot channel project lands and managed by the U.S. Fish and Wildlife Service under a "General Plan and Cooperative Agreement".

1.6.1.2 Upper Mississippi River Comprehensive Basin Study

The Upper Mississippi River Comprehensive Basin Study applies to the project area mainly with respect to recreation and wildlife resources. The Basin Study reports that water-based recreation needs of the counties bordering the Mississippi River can be met in the river itself. Pool No. 26 is cited as a good recreation area, but with the drawbacks of limited access, areas of fast water, and conflict between recreational and commercial traffic. The Upper Mississippi River has been considered for a national recreation area, but no authorizing legislation has resulted from the studies.

1.6.1.3 Upper Mississippi River National Recreation Area Study

In 1971, the U.S. Department of the Interior and U.S. Army Corps of Engineers jointly prepared the Upper Mississippi National Recreation Area Study which examined the opportunities and feasibility for a National Recreation Area extending along the Mississippi River from St. Louis to the Minneapolis area. The study recommended Federal purchase of considerable acreage along the river, both in fee and in scenic easement. Twenty major recreation units along the river were proposed, often in conjunction with existing state parks or other public holdings. No authorizing legislation has resulted from this study to date, nor is there any active support of this project in Congress at this time.

1.6.2. STATE AGENCY PLANS

1.6.2.1 Illinois Department of Conservation

The Illinois Department of Conservation manages approximately 17,000 acres of 9-foot channel project land along the Illinois and Mississippi Rivers, under the same "General Plan and Cooperative Agreement" arrangement as for the U.S. Fish and Wildlife Service. On most of this land, fishing, hunting, boating, and related activities are provided. An additional 862 acres owned by the Illinois Department of Conservation, and Pike County Conservation Area located on the Illinois River, are managed for upland game.

1.6.2.2 State of Illinois Recreation Plan

The Action Plan for Outdoor Recreation in Illinois was prepared by the State of Illinois Department of Business

and Economic Development and presented to Governor Ogilvie on 24 November 1969. The plan considers the recreational needs and potentials of Illinois in terms of four major regions. Region IV covers the southern part of the state, including the cities of Alton and East St. Louis and includes three major reservoirs and a national forest. Largely because of these assets and because of the relatively small population, Region IV appears to have a surplus of recreational land. However, for the five-year planning period ending in 1975, the Action Plan recommends acquisition of 65,894 acres and expenditures of $26,689,000 in federal, state and local funds for development in Region IV.

In 1974, the State of Illinois Department of Conservation published Illinois Outdoor Recreation. The document discusses the state's existing outdoor recreation resources, identifies the concerned federal and state agencies, and sets forth the recreation goals and objectives which the state will pursue.

1.6.2.3 Missouri Department of Conservation

The approximately 12,000-acre Upper Mississippi River Wildlife Management Area, located on 9-foot channel project lands along the Mississippi River, is operated by the Missouri Department of Conservation in accordance with the "General Plan and Cooperative Agreement". Hunting, fishing, and other recreational activities are provided on these lands.

1.6.2.4 State of Missouri Recreation Plan

The State of Missouri Outdoor Recreation Plan of December 1970 showed that throughout the state, there is only a minor projected need for additional facilities for camping, picnicking, boating (including water skiing), and sailing. However, there is a significant demand for fishing and swimming. The St. Louis Metropolitan Area is shown to need increased fishing, swimming and hiking facilities. However, this was not substantiated by Harland, Bartholomew, and Associates, in Locks and Dam No. 26 (Replacement) Design Memorandum No. 8. Their analysis, using the same data analyzed in the State Plan, shows that is is not likely that both public and private outdoor recreation facilities can possibly keep up with the demands of the people of the metropolitan area for outdoor recreation.

1.6.3 LOCAL AGENCY PLANS

1.6.3.1 St. Charles County

The Land Use and Transportation Plans for St. Charles County contain a number of proposals for the eastern end of St. Charles County in the vicinity of Alton Lake and the replacement locks and dam facility. Specifically, the Alton Lake shoreline is designated for recreational residences and recreation-oriented development. In addition, St. Charles County has recently formed a St. Charles County Port Authority which is interested in the development of commercial ports.

PART 2

2. EXISTING ENVIRONMENTAL SETTING

2.1 PHYSICAL ELEMENTS

2.1.1 REGIONAL GEOLOGICAL ELEMENTS

2.1.1.1 Physiography

The landforms of the study area may be classified as to their regional variation, vis a vis topography (local relief, slope) and geology (bedrock materials, structure). In the National Atlas, 1970 (Hammond, "Classes of Land-Surface Form") the region is classified as an area of "Irregular Plains" with a local relief of 300 to 500 feet and from 50 to 80 percent of the surface gently sloping. Also, from 50 to 75 percent of the gentle slope is on the divides between the stream valleys.

The bluffs along the floodplains are highly variable as to their local relief and slope. This variability is in direct relationship to the hardness of the bedrock in which the streams have incised their respective channels. The gentle slope of the upland surface is due to the mantle of unconsolidated glacial materials (drift, loess) which tends to subdue the topographic profiles. The large alluvial valleys of the Mississippi and Illinois Rivers, in contrast, are level with only minor topographic differences.

Landforms in the U.S. have also been classified into physiographic regions which have a certain amount of homogeneity in terms of topography, rock units and structure. The Fenneman (1938) classification places most of the study area in the Central Lowland Province, a region which covers much of the Mid-West (Figure 2-1). The province may be subdivided into smaller units called sections. The United States Geological Survey's Physical Divisions Map of the U.S. (1946) places the unit of the study region east of the Mississippi River in the Till Plains Section (young till plains; morainic topography rare; no lakes) and the unit west of the Mississippi is the Dissected Till Plains Section (submaturely to maturely dissected till plains).

Several writers (Shepard, 1907. Rubey, 1952. Leighton, et. al., 1948) have disagreed with the inclusion of most of the area between the Mississippi and Illinois Rivers in Calhoun and Pike Counties, Illinois and Lincoln, St. Charles and Pike Counties, Missouri in the Central Lowland Province (Figure 2-2). Rubey and Shepard who performed detailed field work in parts of the study area wrote that the area in question more closely resembled the Ozark Plateaus Province and Rubey suggested

PHYSIOGRAPHIC DIVISIONS OF THE MIDWESTERN U.S.

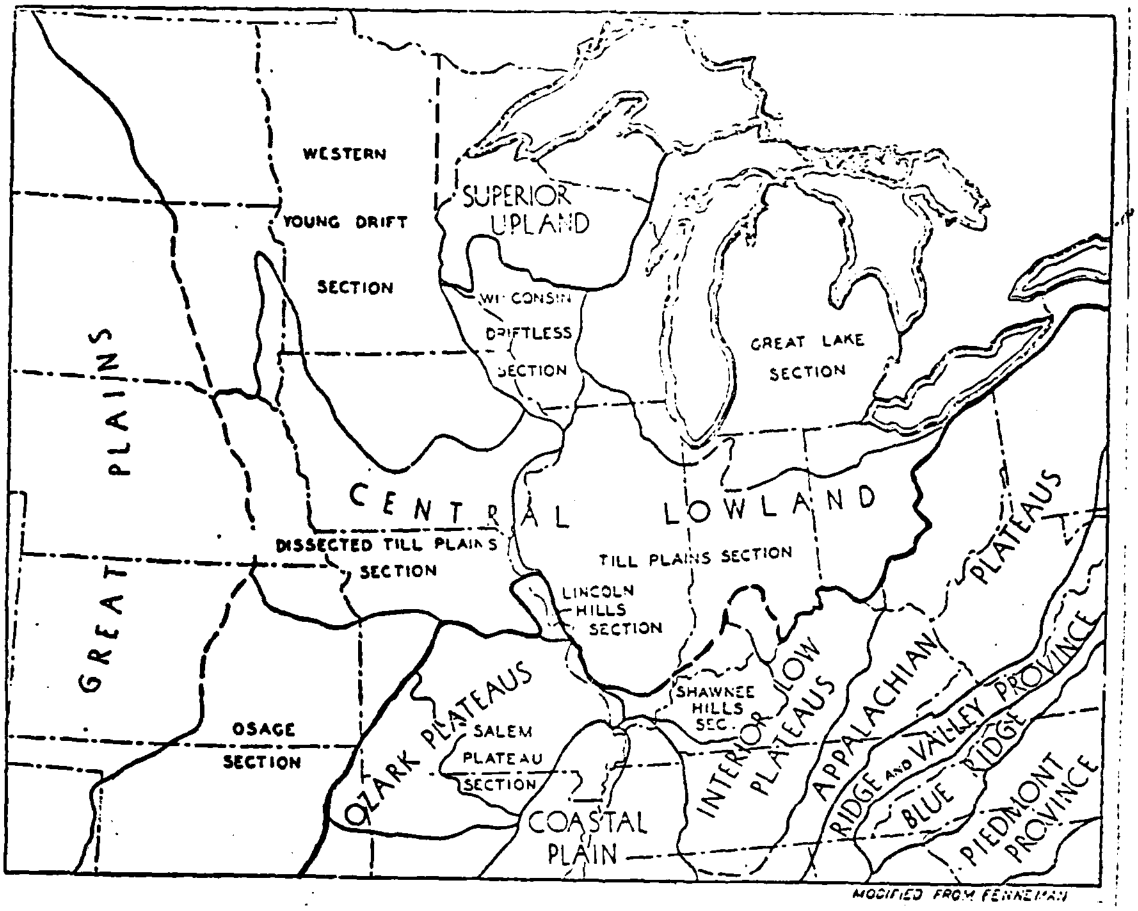
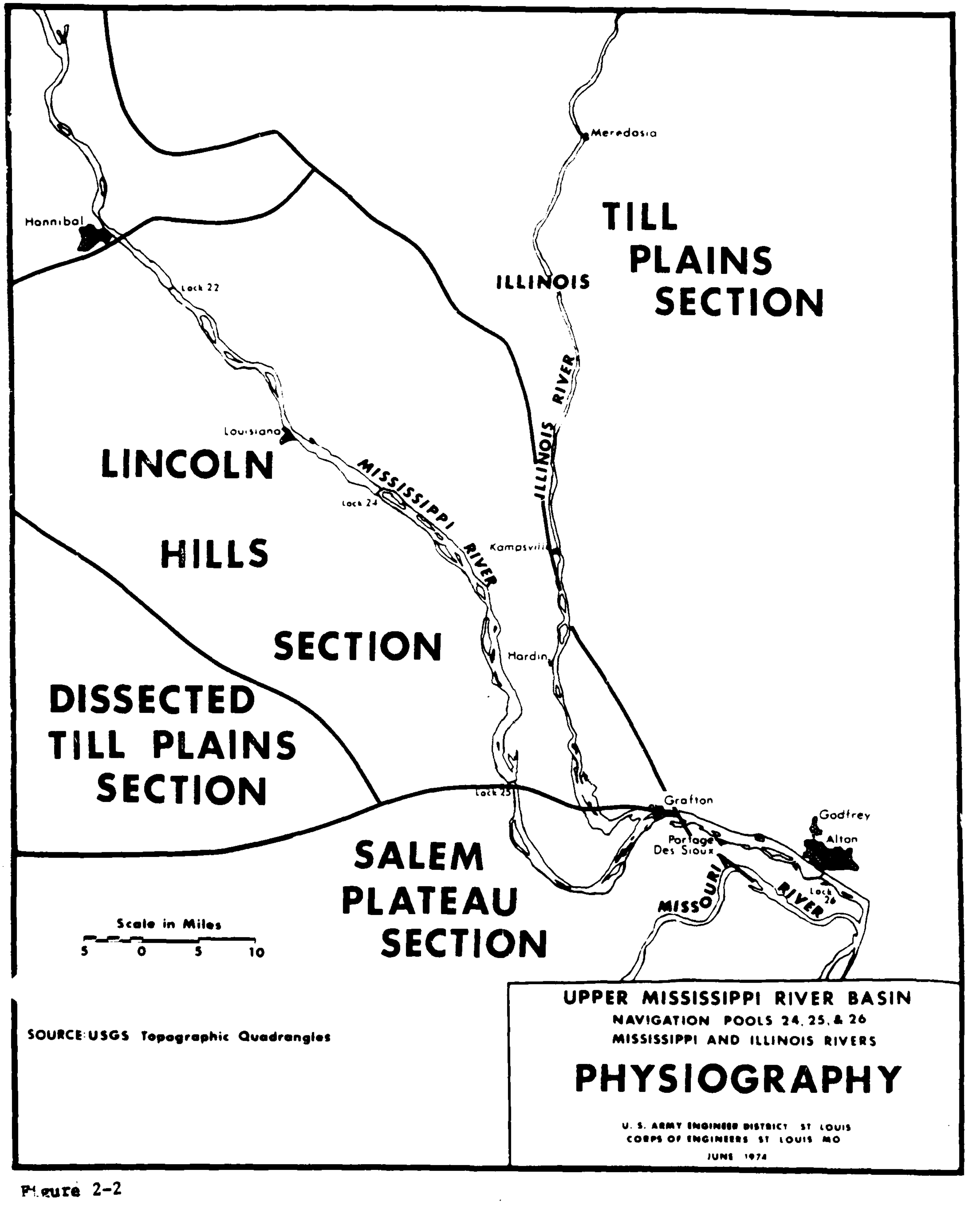


Figure 2-1

*Source: Illinois State Geological Survey. Report of Investigations 129, 1956.



Meredosia
TILL
PLAINS
SECTION
ILLINOIS
RIVER
Hannibal
Lock 22
Louisiana
LINCOLN
HILLS
SECTION
MISSISSIPPI RIVER
Lock 24
ILLINOIS
Kampsville
Hardin
DISSECTED
TILL PLAINS
SECTION
Lock 25
Grafton
Godfrey
Portage Des Sioux
Alton
SALEM
PLATEAU
SECTION
MISSOURI
RIVER
Lock 26
Scale in Miles
5 0 5 10
SOURCE: USGS Topographic Quadrangles
UPPER MISSISSIPPI RIVER BASIN
NAVIGATION POOLS 24, 25, & 26
MISSISSIPPI AND ILLINOIS RIVERS
PHYSIOGRAPHY
U. S. ARMY ENGINEER DISTRICT ST LOUIS
CORPS OF ENGINEERS ST LOUIS MO
JUNE 1974

Figure 2-2

that the name Lincoln Hills Section of the Ozark Plateaus Province be applied to the area. Leighton, Ekblaw and Horberg agreed to this change.

The Lincoln Hills Section is an upland which is developed along the Lincoln fold, a secondary structure of the larger Ozark dome to the west. The Mississippi River cuts through this structure. Most of the section has not been glaciated, in contrast to areas to the east and west. The northern boundary is arbitrarily chosen as is the eastern and western border. The contact line is generally drawn along the line of maximum glaciation in the region. The southern boundary in Calhoun County is along the Cap au Gris faulted flexure.

Leighton, et al., also placed the southern section of Calhoun County and portions of Jersey, Madison, and St. Clair counties, Illinois and sections of St. Louis and St. Charles counties, Missouri in the Salem Plateau Section of the Ozark Plateaus Province. This was done on the basis of topography, bedrock and structure.

2.1.1.2 Historical Geology and Stratigraphy

The main events in the geologic history of the study area which account for the bedrock distribution, structural features and the surficial materials of the uplands and alluvial valleys are summarized as follows: (1) Sedimentary rock units, some 4,000 to 5,000 feet thick were deposited over Precambrian extrusive and intrusive igneous rocks by alternate inundation and regression of semi-tropical or tropical seas. The marine phases were the most persistent. (2) During the Paleozoic Era, the area to the east of the Mississippi River began to subside, creating a spoon shaped depression called the Illinois Basin. Thus, the rock which comes to the surface at Alton is several thousand feet under the surface in Central Illinois. Also during the Paleozoic Era the Ozark Dome began to rise and the Lincoln Fold and the Cap Au Gris Faulted Flexure were formed. (3) During the Pleistocene Epoc or Ice Age, about 1,000,000 years ago, great continental ice sheets moved into the mid-latitudes of the United States and the Mid-west was over-run by at least four different glaciers. The glaciers deposited drift on the uplands and filled the alluvial valleys with outwash. (5) During the Holocene Stage (recent) the upland surface has been eroded and modern soils created while in the alluvial valleys some of the valley fill has been scoured away and subsequent river changes and flooding has created the present day floodplain morphology and alluvial soils.

Figure 2-3 illustrates the age of the surficial bedrock of the study area if the overlying mantle of younger Pleistocene and Holocene drift and soils were stripped away. The exposed bedrock varies in age from Ordovician to Cretaceous.

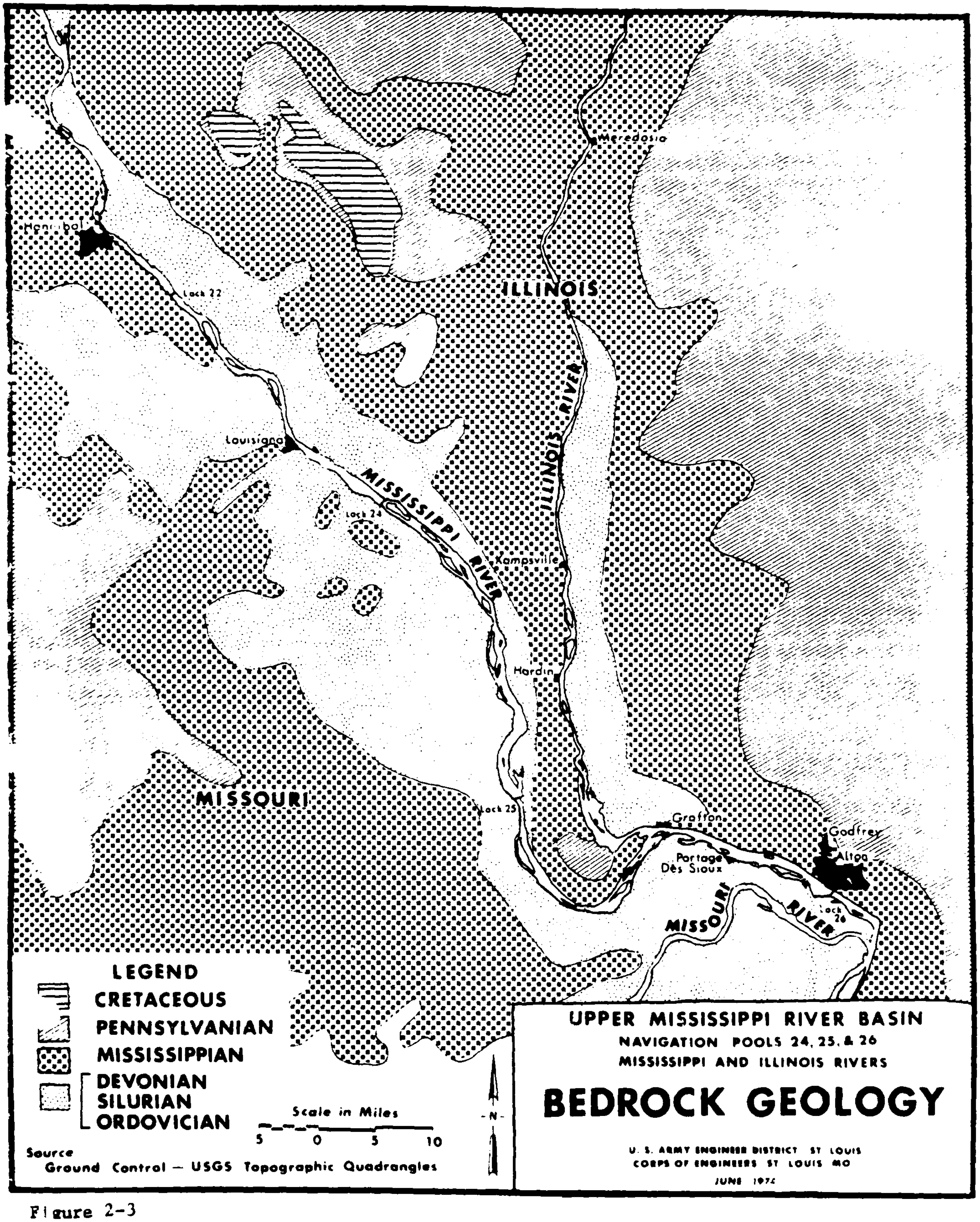

Meredosia
Hannibal
Lock 22
ILLINOIS
ILLINOIS RIVER
Louisiana
MISSISSIPPI RIVER
Lock 24
Kampsville
Hardin
MISSOURI
Lock 25
Grafton
Godfrey
Alton
Portage Des Sioux
MISSOURI RIVER
Lock 26
LEGEND
CRETACEOUS
PENNSYLVANIAN
MISSISSIPPIAN
DEVONIAN
SILURIAN
ORDOVICIAN
Scale in Miles
5 0 5 10
N
Source
Ground Control — USGS Topographic Quadrangles
UPPER MISSISSIPPI RIVER BASIN
NAVIGATION POOLS 24, 25, & 26
MISSISSIPPI AND ILLINOIS RIVERS
BEDROCK GEOLOGY
U. S. ARMY ENGINEER DISTRICT ST LOUIS
CORPS OF ENGINEERS ST LOUIS MO
JUNE 1974

Figure 2-3

Figure 2-4 is a generalized geological column for the upper Mississippi River Basin. Names of geological units are not always the same in Missouri and Illinois as mapping was performed by different agencies at different times. For a more complete review of the bedrock stratigraphy of Missouri, the reader should refer to Howe and Koenig, 1961 and for Illinois, Willman, H.B. et al., 1975.

Within the alluvial valleys, the Pleistocene and Holocene are the most important segments of geologic time that explain the present day river morphology (see Figure 2-5). The study area was invaded by three ice sheets. Little is known about the extent of the Nebraskan (first) glacial stage in the study area. The Kansan (second) sheet approached the region from both a northeasterly and northwesterly direction (Figure 2-6). The northwestern lobe moved as far south as St. Charles County and blocked the Mississippi River near the present day Lock and Dam 25 and for a short period of time the ancient Iowa River (Modern Mississippi River) was diverted east across Calhoun County into the ancient Mississippi Channel (Modern Illinois River) creating the Batchtown Channel. The northeastern lobe pushed westward almost to the Illinois River.

The Illinoian (third) ice sheet moved into the river basin again from the northeast and overrode most of the eastern Kansan lobe and a part of the western lobe (Figure 2-7). The glacier moved across the Mississippi below the confluence with the Illinois creating an ice dam and Lake Brussels, the supposed origin of the highest terrace, in the lower Illinois River (see Willman and Frye, 1970, p. 28 for a discussion of the age of the Brussels Terrace).

The Wisconsinan (fourth) glaciers did not enter into the study area but the melting ice contributed silts, sands and gravels to the two river valleys. Both streams became overloaded and "silted up" creating a higher floodplain than today but not as high as the Brussels level. Figure 2-8 illustrates a cross-section of the lower Illinois valley. As can be seen the Brussels Terrace (Illinoian) and Deer Plain Terraces (Wisconsinan) are today elevated above the present floodplain.

Also, during Wisconsinan and early Holocene time the river valleys became source areas for loess, a wind blown dust. Loess consists primarily of silt sized particles and fine sand. The dominant wind direction during the time of loess accumulation was from the northwest and west, thus the loess is thickest near the valley source and thins to the east. Loess is the dominant surficial material on the uplands and is the parent material for most of the modern soils.

Thus, locally the glaciers had only a minor effect upon the river valleys, but on a regional scale the effect was profound. The ice sheets buried some river valleys, caused

GENERALIZED GEOLOGICAL COLUMN FOR THE UPPER MISSISSIPPI RIVER FLOODPLAIN AND VICINITY

ERA	SYSTEM	SERIES		STAGE	GROUP	FORMATION	YEARS BEFORE PRESENT	
.CENOZOIC	QUATERNARY	PLEISTOCENE "ICE AGE"		RECENT			7,000 TO PRESENT	"AGE OF MAMMALS"
				WISCONSINAN (Glacial)			75,000	
				SANGAMONIAN (Interglacial)				
				ILLINOIAN (Glacial)				
				YARMOUTHIAN (Interglacial)				
				KANSAN (Glacial)				
				AFTONIAN (Interglacial)				
				NEBRASKAN Glacial)			1,000,000	
	TERTIARY						63,000,000	
MESOZOIC	CRETACEOUS	GULFIAN					135,000,000	"AGE OF REPTILES"
PALEOZOIC	PENNSYLVANIAN	DES MOINESIAN			KEWANEE (ILLINOIS)	[illegible] (ILLINOIS)		"AGE OF AMPHIBIANS AND EARLY PLANTS"
		ATOKAN				ARBONDALE (ILLINOIS)		
						[illegible] (ILLINOIS)		
		MORROWAN			McCORMICK (ILLINOIS)	[illegible] (ILLINOIS)	[illegible]	
	MISSISSIPPIAN	CHESTERIAN (MISSOURI)	UPPER CHESTERIAN (ILLINOIS)					
			LOWER CHESTERIAN (ILLINOIS)					
		MERAMECIAN (MISSOURI)	UPPER VALMEYERAN (ILLINOIS)					
			MIDDLE VALMEYERAN (ILLINOIS)					
			LOWER VALMEYERAN (ILLINOIS)					
		OSAGEAN (MISSOURI)						
		KINDERHOOKIAN					345,000,000	
	DEVONIAN		MIDDLE DEVONIAN (ILLINOIS)					"AGE OF FISHES"
			LOWER DEVONIAN (ILLINOIS)				405,000,000	
	SILURIAN						425,000,000	
	ORDOVICIAN	CINCINNATIAN		RICHMONDIAN (MISSOURI)	MAQUOKETA (ILLINOIS)	MAQUOKETA (MISSOURI)		"AGE OF INVERTEBRATES"
		CHAMPLAINIAN		MOHAWKIAN (MISSOURI)	GALENA (ILLINOIS)	DECORAH (MISSOURI)		
					PLATTEVILLE (ILLINOIS)	PLATTIN (MISSOURI) (SUBGROUP IN ILLINOIS)		
				CHAZYAN (MISSOURI)	ANCELL (ILLINOIS)	JOACHIM (MISSOURI)		
						DUTCHTOWN (MISSOURI)		
						ST. PETERS (MISSOURI)		
						EVERTON (MISSOURI)		
		CANADIAN				SMITHVILLE (MISSOURI)		
						POWELL (MISSOURI)		
						COTTER (MISSOURI)		
						JEFFERSON CITY (MISSOURI)	500,000,000	
	CAMBRIAN						600,000,000	
	PRECAMBRIAN							

.THERE IS NO UNIVERSALLY ACCEPTED TIME-STRATIGRAPHIC EQUIVALENT FOR THE GEOLOGICAL TIME UNIT "ERA". THE EUROPEANS, HOWEVER, USE "ERATHEM."

SOURCES: THE STRATIGRAPHIC SUCCESSION IN MISSOURI, MISSOURI GEOLOGICAL SURVEY AND WATER RESOURCES, 1971
GEOLOGICAL MAP OF MISSOURI, MISSOURI GEOLOGICAL SURVEY AND WATER RESOURCES, SCALE 1:500,000, 1961
GEOLOGICAL MAP OF ILLINOIS GEOLOGICAL SURVEY, SCALE 1:500,000, 1967
GEOLOGICAL TIMETABLE, F.W.B. VAN EYSINGA, 1972

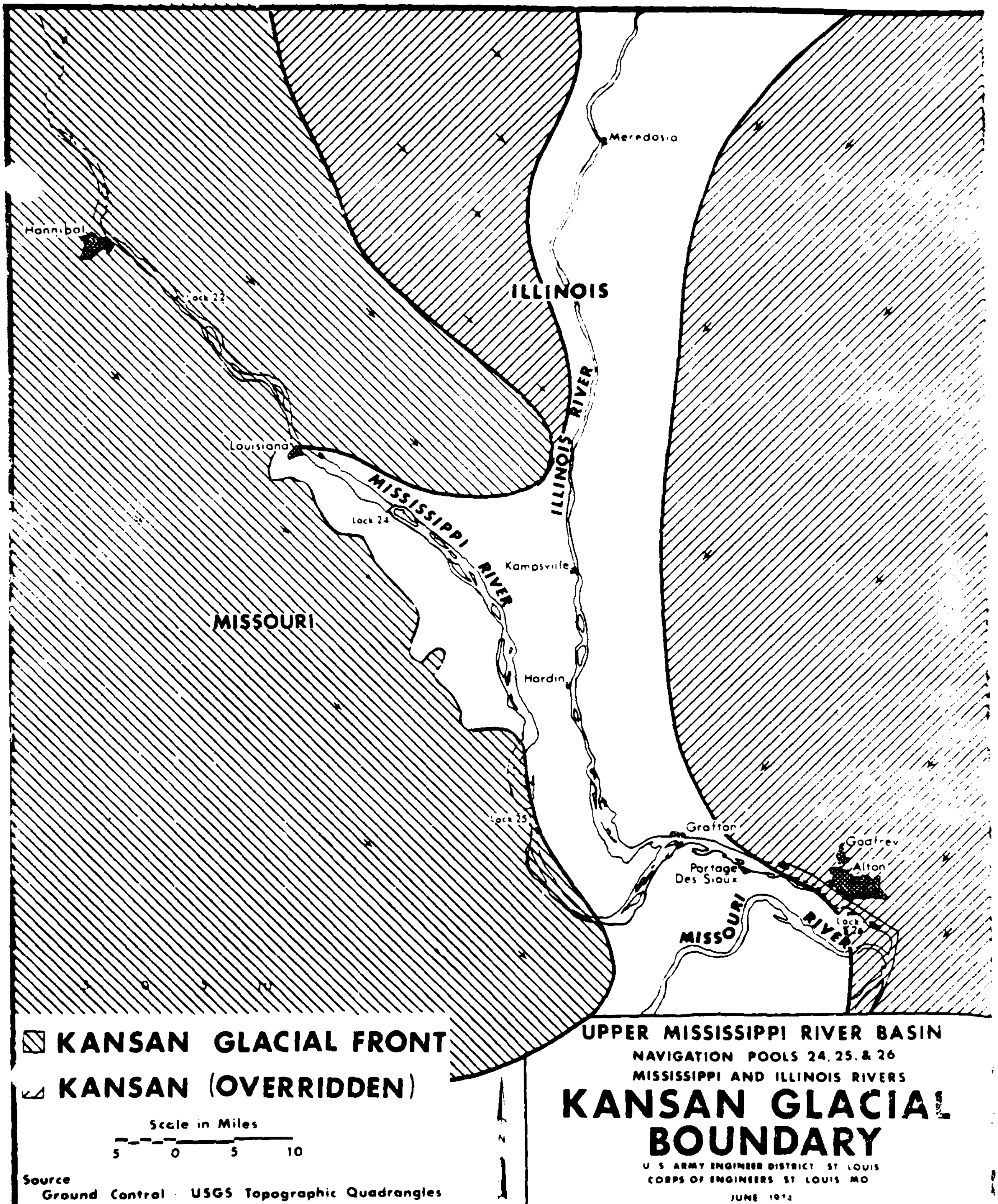
Fig. 2-4. . Generalized geological column for the Upper Mississippi River Region

GLACIAL MATERIALS OF ILLINOIS

AGE				ROCK UNITS				
SYSTEM	SERIES	STAGE	SUBSTAGE	FORMATIONS				
QUATERNARY	PLEISTOCENE	HOLOCENE		Cahokia Alluvium al, alg, af	Grayslake Peat p	Parkland Sand sw	Peyton Colluvium sp	Lacon Formation*
		WISCONSINAN	VALDERAN					
			TWOCREEKAN					
			WOODFORDIAN	Peoria Loess*	Richland Loess*; Morton Loess*	Wedron Formation tl	Henry Formation gh, gl, sh, sl	Equality Formation gd, sd, sl
			FARMDALIAN	Robein Silt*	Peddicord Formation*			
			ALTONIAN	Roxana Silt*				
		SANGAMONIAN						
		ILLINOIAN		Loveland Silt*	Teneriffe Silt*; Petersburg Silt*	Glasford Formation tl	Pearl Formation sds	
		YARMOUTHIAN		Banner Formation*				
		KANSAN						
		AFTONIAN		Enion Formation*				
		NEBRASKAN						
TERTIARY	PLIOCENE – PLEISTOCENE			Grover Gravel*				

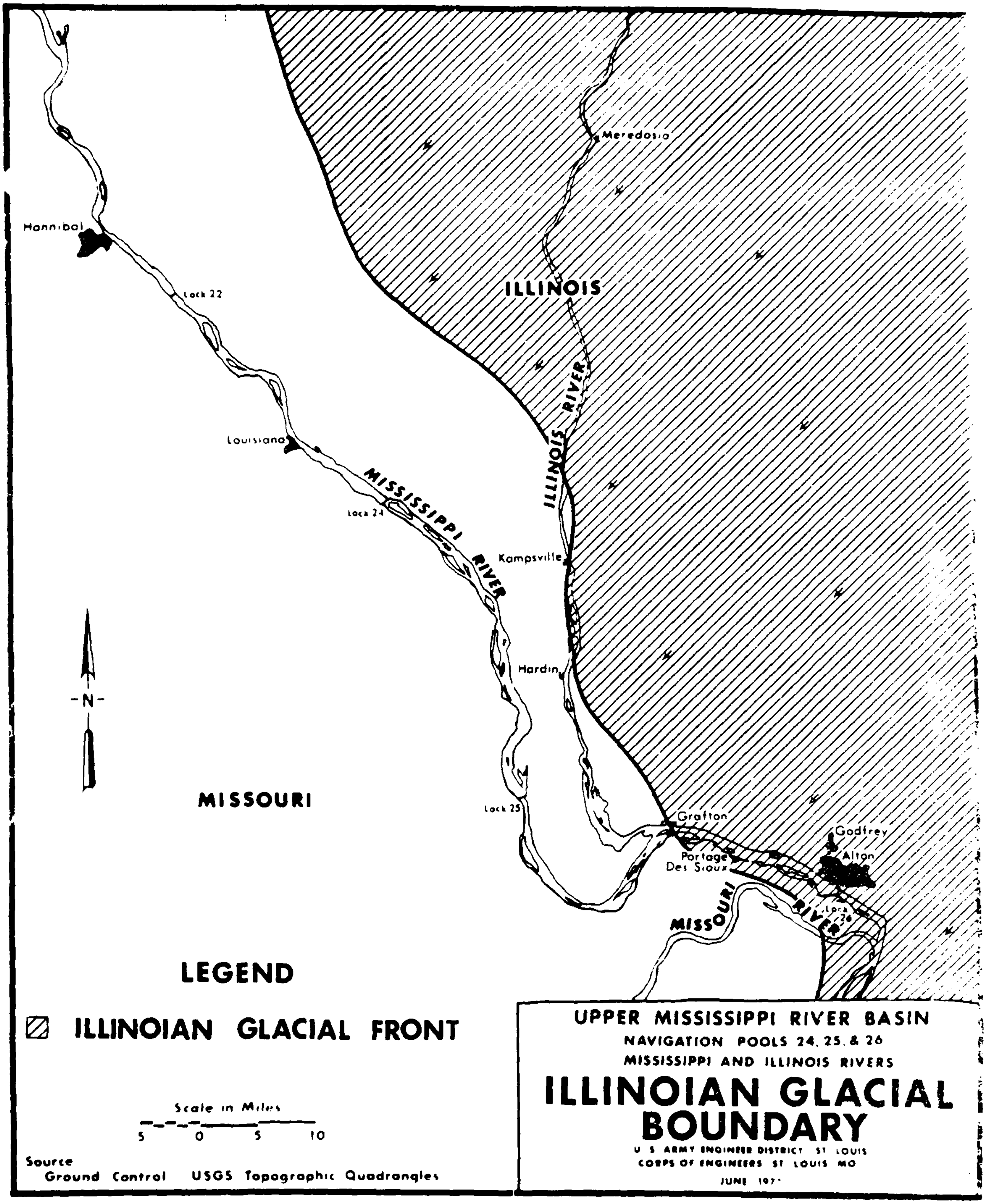
Source: Ill. State Geological Survey, Circular 478, 1973.

Figure 2-5



Meredosia
Hannibal
Lock 22
ILLINOIS
ILLINOIS RIVER
Louisiana
MISSISSIPPI RIVER
Lock 24
Kampsville
MISSOURI
Hardin
Lock 25
Grafton
Godfrey
Portage Des Sioux
Alton
MISSOURI RIVER
Lock 26
KANSAN GLACIAL FRONT
KANSAN (OVERRIDDEN)
Scale in Miles
5 0 5 10
Source
Ground Control USGS Topographic Quadrangles
N
UPPER MISSISSIPPI RIVER BASIN
NAVIGATION POOLS 24, 25, & 26
MISSISSIPPI AND ILLINOIS RIVERS
KANSAN GLACIAL BOUNDARY
U S ARMY ENGINEER DISTRICT ST LOUIS
CORPS OF ENGINEERS ST LOUIS MO

Figure 2-6


Meredosia
Hannibal
Lock 22
ILLINOIS
ILLINOIS RIVER
Louisiana
MISSISSIPPI RIVER
Lock 24
Kampsville
Hardin
N
MISSOURI
Lock 25
Grafton
Godfrey
Alton
Portage Des Sioux
MISSOURI RIVER
Lock 26
LEGEND
ILLINOIAN GLACIAL FRONT
Scale in Miles
5 0 5 10
Source
Ground Control USGS Topographic Quadrangles
UPPER MISSISSIPPI RIVER BASIN
NAVIGATION POOLS 24, 25, & 26
MISSISSIPPI AND ILLINOIS RIVERS
ILLINOIAN GLACIAL BOUNDARY
U S ARMY ENGINEER DISTRICT ST LOUIS
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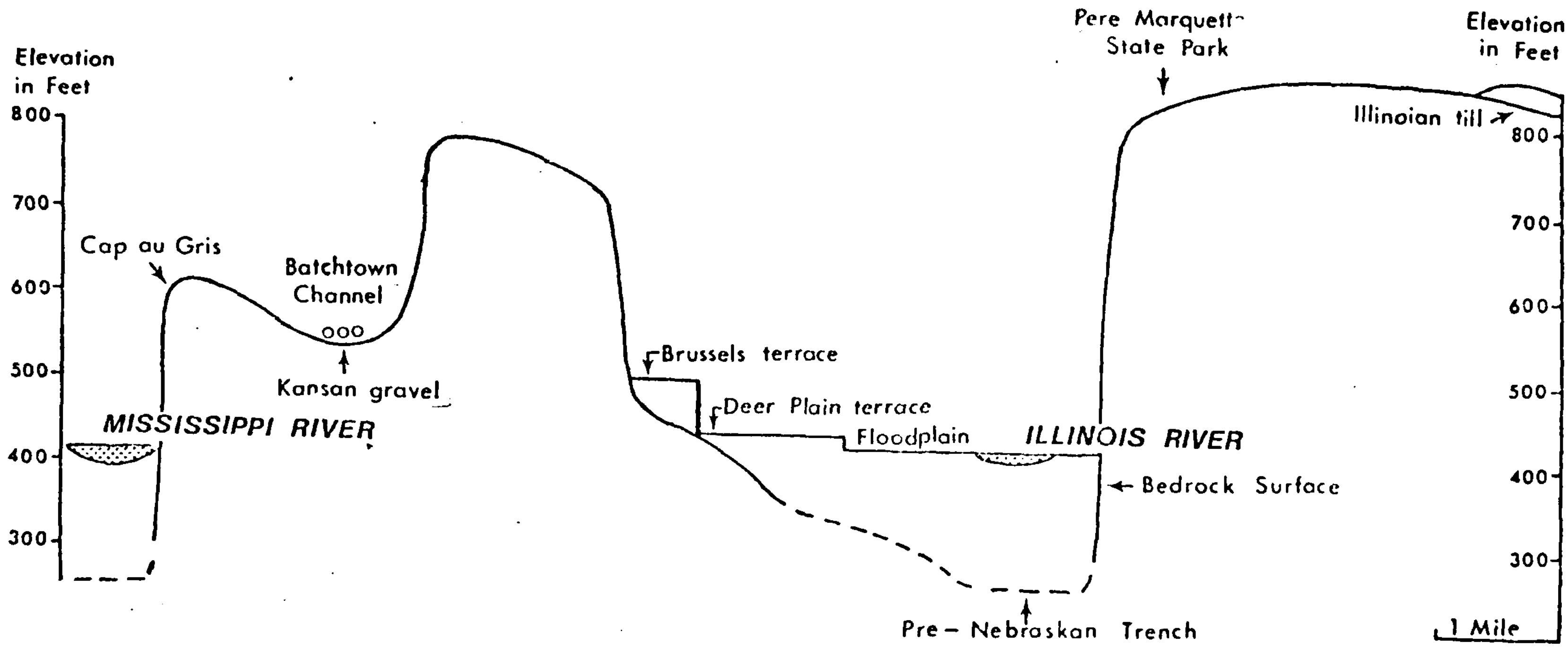
JUNE 197

Figure 2-7

DIAGRAMMATIC PROFILE FROM PERE MARQUETTE STATE PARK TO CAP AU GRIS



SOURCE: ILL. STATE GEOLOGICAL SURVEY, GUIDE BOOK, 1954.

Figure 2-8

some rivers to change channels and created new drainageways.

Figure 2-9 illustrates the major changes in the Missis-sipi and Illinois drainage systems during the Pleistocene. During Kansan continental glaciation (Figure 2-9b) which materially influenced the drainage patterns, the western system was diverted by the ice to the east to join the eastern system at Hennepin, Illinois. This large glacial river cut a deep bedrock valley, now abandoned, between Fulton and Hennepin, Illinois. At the same time, the ancestral Ohio River was forced to the south and the eastern system was greatly reduced in size (Frye et. al., 1965). The large size of the Illinois River valley in comparison to its present discharge can be attributed to the large discharges of this period as well as to large flood events.

Following the Kansan glaciation, the drainage reestablished a pattern (Figure 2-9c) similar to that of the Aftonian interglacial period (Figure 2-9a) with the ancient Mississippi River occupying the Illinois Valley and the ancestral Iowa River occupying the present Mississippi River Valley.

During the Illinoian glaciation (Figure 2-9d) the ice sheet advanced from the northeast and forced the ancient Mississippi westward from its channel in the Illinois Valley to form a temporary channel crossing eastern Iowa. During this time, a lobe of the ice sheet advanced westward and partly blocked the Mississippi Valley at St. Louis. This caused deposition upstream of St. Louis and the formation of an alluvial deposit (Brussels Terrace) in both the Upper Mississippi and Illinois Valley.

Following the retreat of the ice during the Sangamonian interglacial period (Figure 2-9e) the Mississippi reoccupied the Illinois Valley, and the Iowa River again passed through the present Mississippi Valley.

A late advance of the Wisconsin ice (Figure 2-9f) forced the Mississippi into its present valley. The Illinois River, now draining a much reduced area, occupies the valley formed by the ancient Mississippi. During the retreat of the ice (Figure 2-9g) major floods moved through the Illinois Valley as ice dams failed and glacial lakes drained in the Chicago area. By the end of the Wisconsin glaciation (Figure 2-9h), the existing drainage patterns of the Upper Mississippi and Illinois Rivers were established.

Even after the retreat of the ice sheet from the study area, the Mississippi River was strongly influenced by the presence of the ice sheets to the north. Large quantities of glacial debris and melt water moved through its channel and

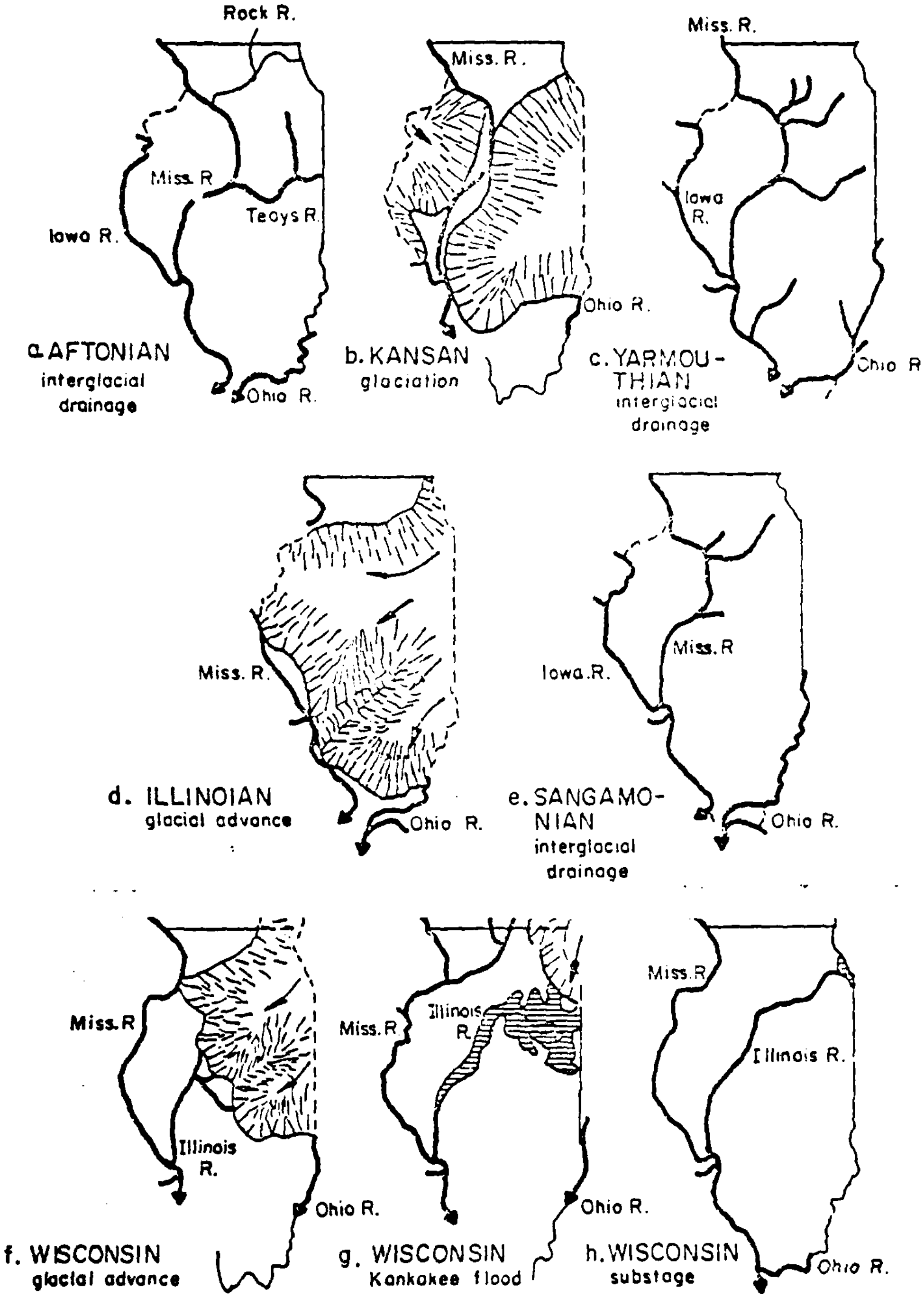


Figure 2-9 Pleistocene changes - Mississippi and Illinois Rivers
"Reprinted by permission of Princeton University Press."

deposition occurred in its valley. When the ice front moved farther north, the reduction in sediment load caused the river to incise to depths of 50 to 75 feet, and subsequent widening of the channel and terrace and floodplain development occurred in postglacial time.

The remnants of the Ice Age are the wide valleys formed by melt waters of the receding glaciers and partially filled with glacial outwash sands and gravels. Within the study reach, the average width of the Upper Mississippi River Valley floor is 5.6 miles and the slope of the floodplain is approximately 0.5 ft./mile. In the Lower Illinois, the valley floor is 4.1 miles wide and slopes approximately 0.25 ft./mile. The floodplain in the vicinity of the Illinois and Upper Mississippi confluence is higher than it is immediately upstream in either valley. Apparently, the Missouri River is responsible for this local increase in floodplain elevation.

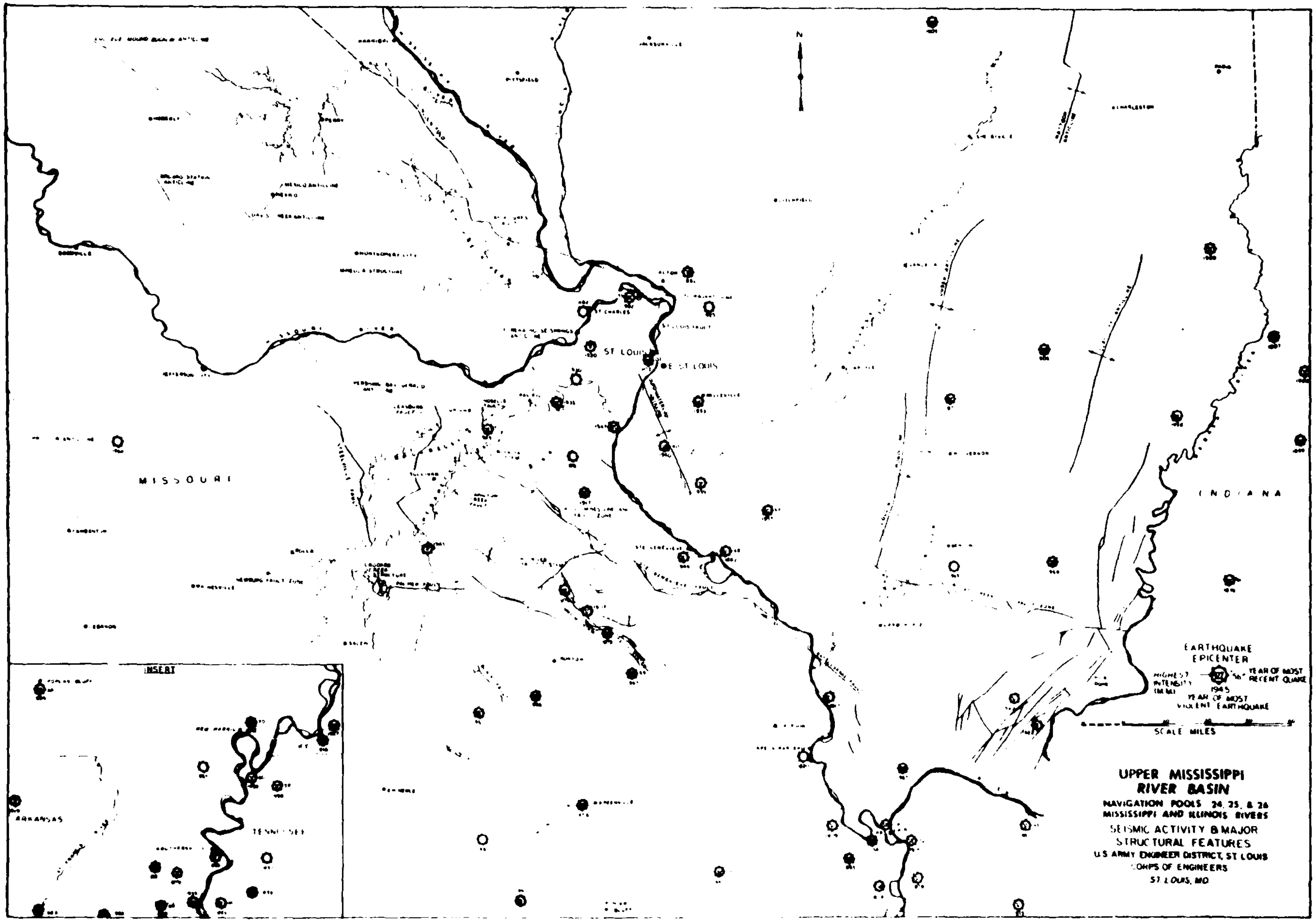
2.1.1.3 Structural Geology and Seismic Activity

The broad tectonic framework of the study area includes the Illinois Basin east of the study area and the Ozark Dome to the west of the area. The most important minor structures within the Upper River area are the Lincoln Fold and the Cap au Gris faulted flexure (Figure 2-10). Examination of satellite multispectral imagery data (ERTS-1) for northeastern Missouri shows that the fold swings east towards the Cap Au Gris structure (Allen, et. al., 1973), but the relationship of the fault to the Lincoln Fold is unclear.

The Cap au Gris fault zone crosses the Mississippi River about one mile south of Cap au Gris, Missouri and the Illinois River near Meppen, Illinois. The displacement along this feature is about 1,100 feet and the alluvium in the Mississippi Valley is only 25 feet thick over the structure. Rubey (1952, p. 146) concluded that there has been no recent movement along this fault zone because the Pleistocene terraces (Deer Plain, Brussels) are not warped or displaced where they cross the fault.

Figure 2-10 also illustrates the epicenters of known earthquakes and the intensity of the quake on the Modified Mercalli (m.m.) Intensity Scale. Epicenter is the point on the surface vertically above the first breach in the bedrock. The m.m. scale measures the severity of shaking indicated by physical damage to structures (Table 2-1). Loose, unconsolidated materials, such as found in the alluvial valleys, tend to amplify the ground displacement caused by an earthquake which causes the intensity to increase (Nuttli, 1973, p. 13).

The largest known earthquakes that have affected the



N
ST LOUIS
E ST LOUIS
ST CHARLES
MISSOURI
INDIANA
INSERT
ARKANSAS
TENNESSEE
EARTHQUAKE
EPICENTER
HIGHEST INTENSITY (M.M.)
YEAR OF MOST RECENT QUAKE
1945
YEAR OF MOST VIOLENT EARTHQUAKE
SCALE MILES
UPPER MISSISSIPPI
RIVER BASIN
NAVIGATION POOLS 24, 25, & 26
MISSISSIPPI AND ILLINOIS RIVERS
SEISMIC ACTIVITY & MAJOR
STRUCTURAL FEATURES
U.S. ARMY ENGINEER DISTRICT, ST LOUIS
CORPS OF ENGINEERS
ST LOUIS, MO

Figure 2-10

Table 2-1

Modified Mercalli Intensity Scale of 1931*

Scale degree	Effects on persons	Effects on structures	Other effects
I	Not felt except by few under favorable circumstances.		
II	Felt by few at rest.		Delicately suspended objects swing.
III	Felt noticeably indoors Standing cars may rock.		Duration estimated.
IV	Felt generally indoors. People awakened.		Cars rocked. Windows, etc., rattled.
V	Felt generally	Some plaster falls.	Dishes, windows broken. Pendulum clocks stop.
VI	Felt by all. Many frightened.	Chimneys, plaster damaged.	Furniture moved. Objects upset.
VII	Everyone runs outdoors. Felt in moving cars.	Moderate damage.	
VIII	General alarm	Very destructive and general damage to weak structures. Little damage to well built structures.	Monuments, walls down. Furniture overturned. Sand and mud ejected. Changes in well-water levels.
IX	Panic.	Total destruction of weak structures. Considerable damage to well built structures.	Foundations damaged. Underground pipes broken. Ground fissured and cracked.
X	Panic.	Masonry and frame structures commonly destroyed. Only best buildings survive. Foundations ruined.	Ground badly cracked. Rails bent. Water slopped over banks.
XI	Panic.	Few buildings survive	Broad fissures. Fault scarps. Underground pipes out of service.
XII	Panic.	Total destruction.	Acceleration exceeds gravity. Waves seen in ground. Lines of sight and level distorted. Objects thrown in air.

* Source: Illinois State Geological Survey.

Missouri-Illinois region were the New Madrid shocks of 1811 and 1812. The three largest shocks, centered near New Madrid, Missouri in the Bootheel, were intensities of XI to XII and the aftershocks reshaped the topography of southeastern Missouri, northeastern Arkansas and western Tennessee and Kentucky.

Even though the Cap au Gris faulted flexure and the Lincoln Fold are found in the study area there is no known relationship between seismic activity and the structures. Nuttli, 1973, wrote "It has not been established that there is a causal relationship between these geologic structures and present-day earthquakes. There has been no observed surface faulting associated with earthquakes in the past 100 years in the Central United States, such as commonly is seen along the San Andreas Fault in California" (p. 20). Nuttli wrote further, "There is always a possibility, although remote, that a large magnitude earthquake will occur in a region which previously was considered nonseismic" (p. 42).

2.1.1.4 Ground Water Geology

a. General. The project area lies in the alluvial valley of the Mississippi River. The valley fill consists of approximately 0 to 20 feet of clays and silts (referred to as the "blanket" materials or "top stratum") underlain by approximately 70 to 100 feet of pervious soils (sand, sandy gravels, gravel, cobbles, and boulders). The pervious soils extend to bedrock or, if present, glacial till. The thick layer of pervious soils beneath the top stratum readily conducts groundwater through its interconnected voids, and is referred to as the "aquifer." Where the piezometric surface is within the aquifer, it may also be referred to as the "water table," and the aquifer is said to be an unconfined or water table aquifer. Where the piezometric surface is above the aquifer, in the impervious top stratum or above ground, the aquifer is termed confined or artesian. An intermediate case, in which the top stratum is impervious in comparison to the permeability of the aquifer yet sufficiently permeable to permit significant recharge of the aquifer, is termed "leaky artesian." The aquifers in the project area contain all three types, and particular areas may vary from confined to unconfined conditions, depending upon river stage. In the St. Louis/East St. Louis area, significant withdrawals of groundwater have taken place. In the project area north of the St. Louis area, only minor amounts of groundwater have been withdrawn; consequently, the upper Mississippi Valley and the Lower Illinois Valley probably have large undeveloped groundwater reserves.

The available groundwater data are inadequate to assure supplies at specific locations. For this reason and because of the sudden lateral variations in the permeability of most valley fill, geophysical investigations and test borings are usually required to discover the most favorable locations for groundwater in an area.

b. Aquifer Characteristics. In the natural state (without considering the effects of the existing locks and dams) and at periods of steady river stages, groundwater enters the aquifer by percolation from the surface and flows toward the river, forming a rise in the piezometric surface. In addition to the groundwater movement toward the river, there is movement in a downstream direction at a gradient generally proportional to the gradient of the river. During periods of rising river, as the river stage becomes higher than the adjoining piezometric surface, flow reverses and the river recharges the aquifer. Upon periods of sustained high water such as in the spring, the aquifer may be recharged to the river level, rainfall may superimpose a new component, and the piezometric surface may assume a shape similar to its original configuration at a higher elevation. This phenomenon accounts for seasonal variations in the piezometric surface. In a similar manner, years that are wetter or dryer than average will produce long-term variations in the piezometric surface.

After construction of the existing locks and dams in the late 1930's, the area was changed from an uncontrolled river to controlled pools at relatively constant elevations. As a result, the groundwater regime was changed to its present day situation, which is as described below.

During normal conditions, the stage of the Mississippi River in the project area is lower than the existing locks and dams pools and higher than the tailwater. At and beyond about two miles upstream of an existing dam, groundwater flow from the pool generally balances the accretion. Groundwater flow is from the accretion rise (and usually the pool) to the Missouri River along a path generally perpendicular to the river. Beyond about two miles below an existing dam, groundwater flow is essentially unaffected by the dam and occurs in the natural condition discussed above. Within a two- or three-mile radius of the dam, groundwater movement is a complex situation as water flows from the pool toward both the Missouri River and the tailwater. The tailwater, being closer to the pool and generally at a lower elevation, exerts a greater influence, and groundwater flow from the pool to the tailwater follows a counterclockwise path centered around the south end of the dam.

During above normal river stages and as the pool is drawn down, the groundwater flow situation temporarily reverses and flow is from the river to the pool. As river stages continue to rise and the dam gates are drawn out of the river ("open river" conditions), the dam's influence on the groundwater regime ceases. During a major flood, as overbank flooding takes place, the aquifer becomes totally saturated and the piezometric surface beneath a flooded area becomes coincident with the surface of the floodwaters.

Water from this aquifer, while considered safe for drinking, does require treatment for use in home and city water supplies.

Although untreated water would not endanger health, excessive hardness causes difficulty in washing clothes and decreases wear life. Hardness causes clogs in pipelines, home washers, and water heaters. Treatment methods vary in the study area from no treatment in farm wells to sophisticated methods for the major cities. Basically, these systems aerate the water to remove gases, add lime to remove calcium, magnesium, iron, and adjust the pH, and add chlorine to purify and stabilize the water. The water is also filtered several times during the treatment process. Water hardness is reduced to enhance its usability for cleaning in water systems. Turbidity values for a number of wells exceed the recommended limits; however, this seems to be a local problem of adequate well design and operation, rather than a regional problem.

Water from this aquifer is not unusual or hazardous in its quality. Iron and magnesium contents are high, but this represents a problem of hardness and usability rather than a danger of water quality.

However, there are several conditions which suggest possible sources of groundwater contamination, such as: (1) River bottom accumulation from liquid wastes discharge. (2) Effluents from sewage treatment plants which do not meet State standards. (3) Periodic waste accumulation in recreational boat harbors. (4) Sanitary landfills that are unacceptable by 1974 standards either in original construction or method of operation.

None of these singly or in concert with others is considered to be a real cause for present or future general concern.

2.1.1.5 Economic Geology

The Mississippi and Illinois waterways in the study area are major avenues for the transportation of mineral resources. Most of these heavy bulky commodities originate outside the confines of the region yet a variety of minerals (limestone, sand, coal) are mined in the counties adjoining the rivers.

Within the study area a description of the economic geology may be approached at two levels: (1) Those mineral commodities that lie within the alluvial valley (unconsolidated sands, gravels) and those that are exposed in the bluffs (limestone, shale) adjacent to the floodplain. (2) mineral commodities that are found on a broad regional basis (coal, petroleum) and may be dependent upon surface transportation to trans-shipment points on the rivers.

Plate 6, A-D (Land Use) illustrate the location of the major extractive industries within the alluvial valleys. In early 1975, there were eight stone operations and three sand companies operating in the valleys or the adjacent bluffs.

Table 2-2 lists the value and minerals produced within each county in the study area. For a more complete discussion of commodities that are transported on the rivers see pages 134 to 135.

Table 2-2

Mineral Production in 1972 for Counties Bordering the Mississippi - Illinois Waterways - Upper River Study Area

County	All Minerals Total Value	Minerals Produced - Order of Value
Morgan, Illinois	W* (1970-$2,000)	Sand and Gravel
Scott	W (1971- 618,000)	Stone, clay, sand and gravel
Pike	W (1969- 1,387,000)	Stone, sand and gravel
Greene	W (1969 - 653,000)	Stone
Jersey	190,000	Stone
Madison	W (1969 - 2,749,000)	Stone, petroleum, sand and gravel
Calhoun	W	Stone
Brown	26,000	Petroleum, clay, sand and gravel
Ralls, Missouri	W	Cement, stone, clay
Pike	W	Stone, clay
Lincoln	W (1970 - 486,000)	Stone, clay, sand and gravel
St. Charles	2,301,000	Stone, clay, sand and gravel

*Source: Mineral Yearbook, Area Reports, 1972

W: Withheld to avoid disclosing individual company confidential data.

2.1.2 RIVER CHANNEL CONFIGURATIONS

2.1.2.1 The Natural River

The earliest surveys show the Mississippi River channel on the extreme west side of the valley from Hannibal, Missouri to Clarksville, Missouri except for a few miles north of the town of Louisiana. There the entrance of the Salt River had forced the Mississippi River into mid-valley for a short distance (Section 2.1.2 is taken almost verbatim from a report from Colorado State University).

As the neck of land separating the Mississippi and Illinois Rivers narrows towards the south, the influence of the west bank tributaries, primarily the Missouri River, become increasingly significant and 10 miles south of Louisiana at Clarksville, Missouri, the Mississippi River has shifted across the valley to the eastern bluff, which it reached near Mosier, Illinois. The Upper Mississippi River then followed the eastern bluff to Alton, Illinois. The early township maps show the Lower Illinois River in the same position in its valley as today.

The surface area of a river is the area between the river banks or where the land vegetation ceases. Surface area also includes islands and sandbars exposed during low water.

Islands are defined as areas with land-type vegetation within the channel banks that are separated from the mainland by the main channel and side channels. Riverbed area is defined as the surface area less the area of the islands. Therefore, riverbed area is composed of the area of the main channel plus the area of the side channels.

The surface of the Mississippi River in what is now Pool 25 has been measured from the map compiled from the early township plats. In the early 1800's this surface area was 31.41 sq. miles.

The early township plats show 26 islands in the reach of Mississippi River that is now Pool 25. It is not certain whether all the islands in the reach were surveyed. It is believed that all the large ones were, but some smaller islands may have been ignored.

The total surface area of the 26 islands on the early township plats is 5.550 sq. miles. This represents 18 percent of the surface area of the river.

In Table 2-3 the surface area of some of the islands at the time of the first surveys are listed. Throughout the modern history of the river some of these islands have been changing due to natural or man induced factors.

Table 2-3

Islands in the Natural River

Name	Approx. River Mile	Date of Survey	Surface Area sq. mi
Pool 26:			
Piasa	209	1832	.420
Mason	220	1847	.290
Sweden	234	1818	.018
Peruque	234	1818	.359
Cuivre	236	1818	1.979
Pool 25:			
Turner	245	before 1847	.088
Mosier	260	1821	.467
Coon	267	1816	.165
		1847	.006
Carroll	268	1816	.076
		1847	.118
Clarksville	272	1847	.176
Pool 24:			
Crider	279	1821	.025
Unnamed	280	1821	.050

There is evidence that the Mississippi River was narrowing in some sections. For example, a portion of the Mississippi River floodplain along the left bank opposite Hardin, Illinois was apparently an island when first settled. By 1856 when a resurvey of that part of the township was undertaken the side channel separating the island, called Gilead Island, from the Illinois mainland had partially filled.

Also, there is evidence that the Mississippi River was widening in other sections. Large trees that floated down the river during floods or became lodged on sandbars came from caving banklines and islands.

Prior to 1879, the only hydrographic surveys on the Upper Mississippi River were of local troublesome reaches. However, there is the impression that during the low flow seasons, the rivers were not very deep. During the summer months when river flows were very low and the temperatures warms, Sunday excursionists would walk across the river (Tweet, 1974, p. 205).

In addition to the many islands, sandbars formed on the average of one in three miles (Chief of Engineers, 1930, p. 1189) resulting in water depths of three feet and less.

In present day Pool 25 there were long side channels adjacent to the Missouri bankline at Sandy, Westport and Slim Islands. In 1921, Sandy Chute was approximately 550 feet wide and 3 miles long. The upstream part of Westport Chute was approximately 1100 feet wide, but the lower portion adjacent to and below Kickapoo Island was much narrower, only 600 feet wide. Westport Chute was 3.8 miles long. Slim Chute was, on the average, 500 feet wide and was slightly more than 3.5 miles long.

Immediately above Clarksville, Missouri on the Illinois floodplain, there were many side channels and backwater areas. These areas were probably relics of the river left behind as the river migrated across the floodplain in centuries past.

In the Pool 26 reach most of the chutes were in the section of river between the Cuivre River and the Illinois River. The chute between Cuivre Island and the Missouri bankline was approximately 800 feet wide and 3 miles long.

2.1.2.2 Early Developments

In 1810, the famous riverman Henry Shrieve took 70 tons of lead aboard keelboats at the Galena, Illinois mines and floated the cargo down to New Orleans. He made a profit of $11,000 on the trip (Tweet, 1974, p. 20) thus inaugurating big time commercial navigation on the Upper Mississippi.

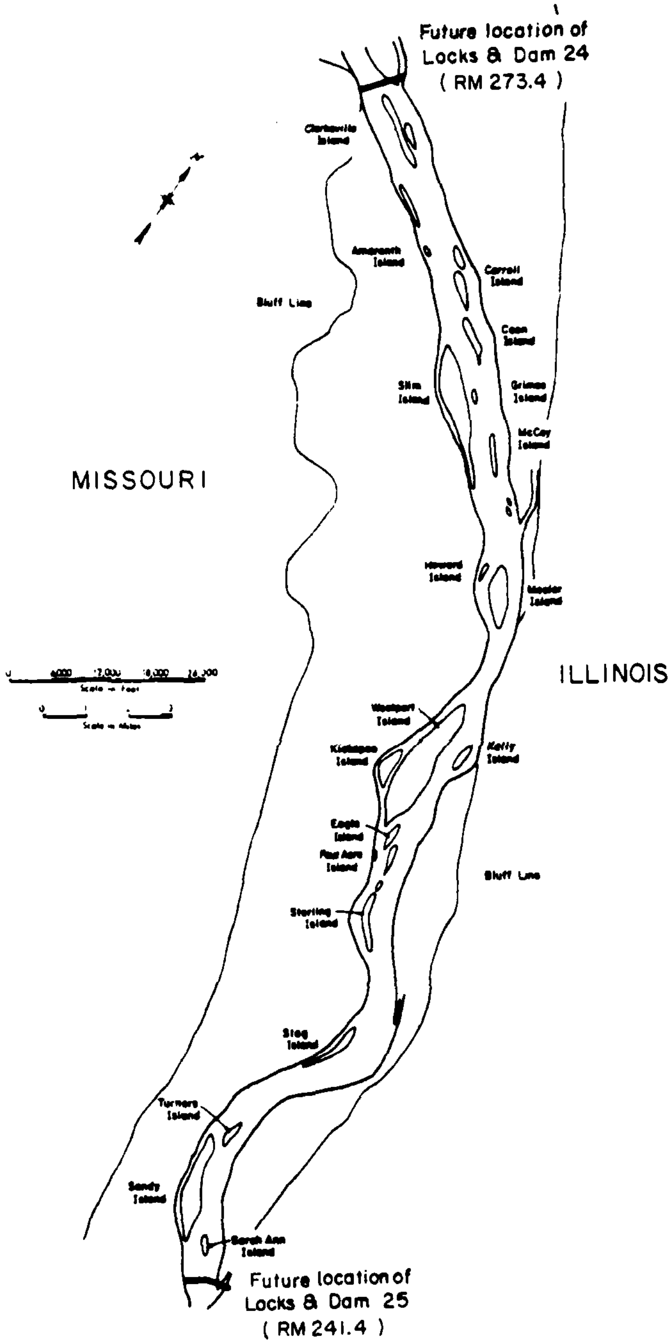


Figure 2-12 Map of the Pool 25 reach of the Mississippi River in the early 1800's

By the 1830's navigation on the upper river system had increased to the level that the Federal Government began navigation improvements using U.S. Treasury funds. The work was not systematic but rather it consisted of removing obstructions such as snags, wrecks, rocks and trees. In some years, the entire budget was used to remove snags.

In the Illinois Valley, the first survey of the Illinois River was made by topographical engineers of the U.S. Army in 1838 and the first snagging operations were authorized in 1852.

In 1864, the Upper Mississippi River dropped to the lowest level ever experienced and navigation came to a halt. The major obstacles were the Des Moines Rapids and the Rock Island Rapids.

The response of Congress came in 1866 with appropriations to improve the navigation depth in these rapids. In the same year, a survey of the Illinois River from its mouth to LaSalle was undertaken. At that time, the intent was to improve the channel to enable steamboats to reach the Illinois and Michigan canal. The results of this survey were preliminary recommendations for one lock and dam, a snag boat, some experimental wing dams, and beacons for the Lower Illinois River.

In 1867, the removal of obstructions such as snags and wrecks became a continuous operation (House Doc. 341, 1906) in the Upper Mississippi River but it was not until 1871 that first official water level gages were installed at St. Louis and Rock Island.

Early experiments with wing dams were not successful but in 1873, C.W. Durham conceived and built a wing dam by driving two rows of poles 9 feet apart along the length of the dam and then filling the space between the rows with brush weighted with sacks of sand (Tweet, 1974, p. 105). The finished dam was 600 feet long and 6 to 10 feet high and closed the chute at the head of Pig's Eye Island 5 miles below St. Paul, Minnesota. Within days after the chute closure, the main channel opened and remained open thereafter.

With a proven method of developing a navigation channel through river reaches shoaled with sand, a permanent and systematic improvement of the Upper Mississippi River was inaugurated in 1878. The original project consisted of (House Doc. 341, 1906, p. 5):

> ...the closure of chutes, revetment of caving banks, and contraction of the channel by wing dams so as to obtain a channel of a depth of 4 1/2 feet at low water, to be eventually increased to 6 feet.

As no complete river channel surveys had been made before this time, the first continuous survey from St. Paul to the Illinois River was undertaken in 1878-1879. This survey formed the data base for the work program.

Actually, no project nor estimate for this entire work "...was ever rendered, it being thought best to present projects from year to year, selecting points known to be most troublesome." (Chief of Engineers, 1915, p. 1882). The intention was to provide a channel 4-1/2 feet deep at low water of 1864.

For this study survey maps titled "Survey of the Mississippi River" made under the direction of the Mississippi River Commission in 1881 were utilized. The secondary triangulation and precise levels were run in 1881 and the topography and hydrography were obtained in 1891. In this report these maps are called the 1891 survey.

Prior to 1891, 41 wing dams were constructed in the study reach of the Upper Mississippi River, 15 of them in what is now Pool 25.

These wing dams were low dikes with crests at a level 6 feet above the 1864 low water and were constructed with rock, brush and sand.

As the amount of work expended on the 4-1/2 foot channel in the study reach of the Upper Mississippi and Lower Illinois Rivers between 1878 and 1891 was very minimal (the rivers were deeper in the study reach than upstream) the 1891 survey is considered representative of river morphology immediately prior to the 4-1/2 foot channel project.

In general, the positions of the Upper Mississippi and Illinois Rivers did not change in the period between the early 1800's and 1891.

For example, the 1891 banklines of the Upper Mississippi River in the reach that is now *Pool* 25 are *shown* in Figure 2-12. By comparing these banklines it is concluded that the right (Missouri) bankline did not move between 1818 and 1891. Parts of the Illinois bankline moved riverward near Carroll and Coon Island and near Stag Island but otherwise the left bankline appeared essentially unchanged.

In 1869, some improvements were made in the Illinois River. The channel was dredged between Henry, Illinois and Copperas Creek on the Upper Illinois River. Wing dams were also built in an attempt to secure a channel at least 150 feet wide and 4 feet deep at low water. By 1871 a lock and dam was built at Henry. One was built at Copperas Creek by 1877. In 1880, Congress approved funds for locks and dams at Kampsville and at La Grange, Illinois with the intent of maintaining a slack water depth of 7 feet to the river mouth. On the lower Illinois the La Grange lock was completed in 1889.

The surface areas of the study reach of the upper Mississippi River was measured on the 1891 survey map and are given in Table 2-4. Compared to the early 1800's, the surface area of the Pool 25 reach had decreased by 1.3 sq. mi. or 4.1 percent in 1891.

The 1891 surface areas of the islands in the study reach of the Mississippi River are given in Table 2-4. In the period between the time of the township surveys and 1891 the number and size of the islands increased substantially. For example, in the Pool 25 reach, there were 26 islands shown on the township maps and 50 islands shown in the 1891 survey map.

Table 2-4

Surface Areas of the 1891 Mississippi River

Location	Surface area, sq. mi. River	Islands	Riverbed
Pool 26:			
Lower quarter	7.480	0.760	6.720
Middle half	16.534	3.819	12.715
Upper quarter	8.577	2.926	5.651
	32.591	7.505	25.086
Pool 25:			
Lower quarter	7.200	1.701	5.499
Middle half	15.145	3.450	11.695
Upper quarter	7.779	2.519	5.260
	30.124	7.670	22.454

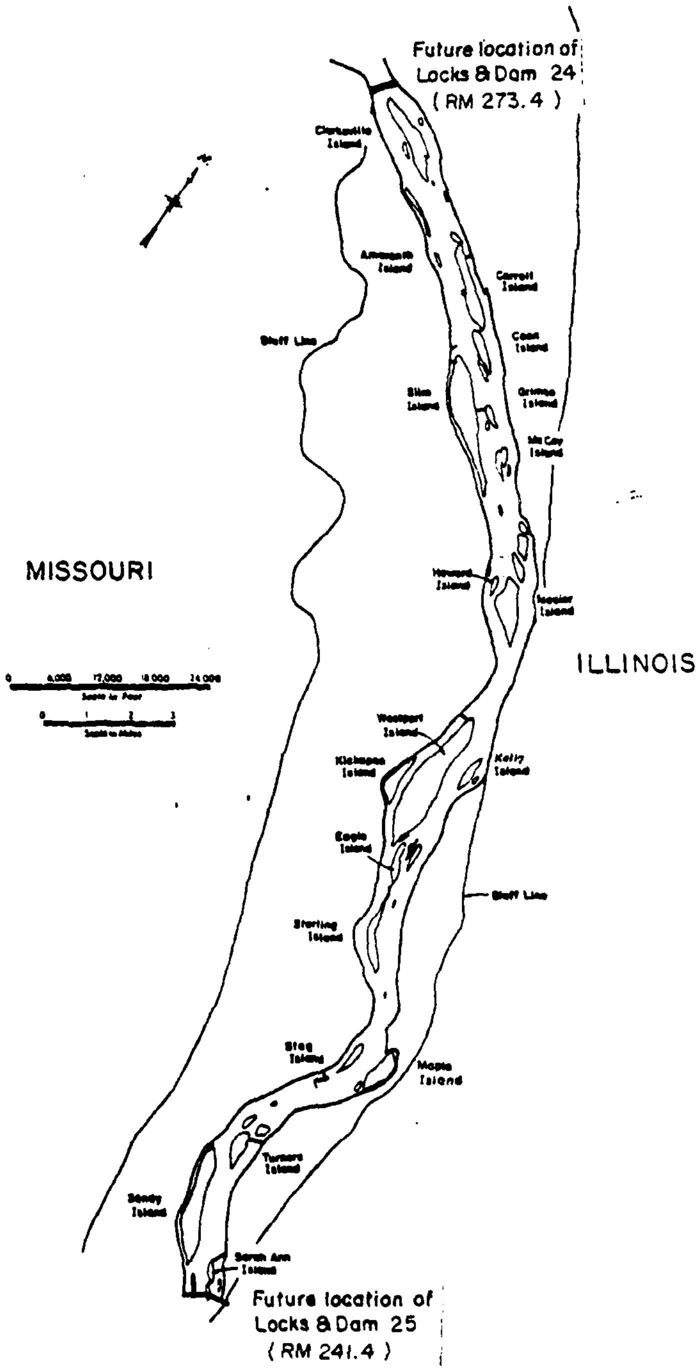


Figure 2-12 Map of the Pool 25 reach of the Mississippi River in 1891

Table 2-4 (con't)

Surface Areas of the 1891 Mississippi River

Location	Surface area, sq. mi.		
	River	Islands	Riverbed
Pool 24:			
Lower quarter	5.598	1.504	4.094
Middle half	11.392	2.123	9.269
Upper quarter	5.937	1.274	4.663
	22.927	4.901	18.026

In Table 2-5, areas of some of the islands are compared. In Pool 25, the five islands listed in Table 2-3 were larger in 1891 than in the early 1800's and in aggregate the island area increased 0.850 sq. mi.

The reason for the growth in the number and size of the islands has not been determined. Possibly the surveyors did not map all the little islands for the township plats. However, they surveyed Four Acre Island in Pool 25 in 1817 and it was only 4.16 acres (0.006 sq. mi.) in size. Possibly, the effect of the great influx of settlers in the valley was to denude the landscape of vegetation and thus produce an increase in sediment load without a corresponding increase in water yield. The response of the river would be to deposit some of this sediment. The result would be more islands but usually the river would also widen with the increased sediment supply. Instead, there was a slight narrowing. A small fraction of the island growth could be attributed to the wing dams that were built between 1878 and 1891, but many more islands grew without the aid of wing dams.

Table 2-5

Changes in Surface Areas of Islands from 1800's to 1891

Name	Approx. River Mile	Surface area, sq. mi. Township1/	1891	Change2/
Pool 26:				
Piasa	209	.420	.383	-.037
Mason	220	.290	.340	+.050
Sweden	234	.018	.056	+.038
Peruque	234	.359	.386	+.027
Cuivre	236	1.979	2.180	+.201
Pool 25:				
Turners	245	.088	.203	+.115
Mosier	260	.467	.477	+.010
Coon	267	.165	.190	+.025
Carroll	268	.076	.428	+.352
Clarksville	272	.176	.524	+.348
Pool 24:				
Crider	279	.025	.165	+.140
Unnamed	280	.050	.188	+.138

1/ From Table 1

2/ A positive change indicates growth of the island and a negative change denotes a decrease in size.

The average widths of the Mississippi River in the study reach in 1891 are given in Table 2-6. The average width was determined by first measuring the surface area of the river reach and then dividing by the length of the reach, measured along the centerline of the river.

Table 2-6

Average River Surface Widths and Riverbed Elevation in the 1891 Mississippi River

Location	Surface Width ft.	Riverbed Elevation* ft. Amsl
Pool 26:		
Lower quarter	4180	392.0 1/
Middle half	4620	399.8 2/
Upper quarter	4790	403.9
Pool 25:		
Lower quarter	4900	409.7
Middle half	5160	417.0
Upper quarter	5300	422.3

Table 2-6 (con't)

Average River Surface Widths and Riverbed Elevation in the 1891 Mississippi River

Location	Surface Width ft	Riverbed Elevation* ft, Amsl
Pool 24:		
Lower quarter	4400	425.5
Middle half	4470	430.7
Upper quarter	4660	435.1

* Average of the riverbed elevations in the deepest 100-ft. width of river channel

1/ Average below confluence with the Illinois
2/ Average in the middle third of Pool 26

The reach of river which is now Pool 24 was very uniform in width and narrower than the other reaches. Pool 25 was on the average 5130 feet wide which was nearly 700 feet wider than Pool 24. However, between the early 1800's and 1891 the river had narrowed approximately 200 feet overall in Pool 25.

In 1891, the Mississippi River was much narrower immediately below the confluence with the Illinois River than above. Coincident with this narrowing, the river did not have many islands downstream of the Illinois confluence.

In general, the 1891 Mississippi River was wider in reaches with many islands and narrower in reaches with fewer islands.

The 1891 survey included a hydrographic survey of the bed of the Mississippi River in the study reach. The average riverbed elevations for different reaches which are now Pools 24, 25 and 26 are given in Table 2-6. The average riverbed elevation for a reach was determined by first obtaining the average bed elevation in the deepest 1000 feet of each cross section and then averaging these numbers to get an average value for the reach.

In general, there were many more side channels in the study reach of the Upper Mississippi River in 1891 than in the early 1800's. The reason for the increase was the proliferation of islands in the river. The side channels in the Pool 25 reach in 1891 are shown in Figure 2-12.

The three long chutes in the Pool 25 reach, Sandy, Westport and Slim did not change much between 1821 and 1891.

Slim Chute widened approximately 50 feet to 550 feet but remained the same length (3.5 miles). Because of the elongation of Sandy Island, Sandy Chute became 0.3 miles longer in 1891 than in 1821. Also, this chute narrowed approximately 150 feet to an average width of 400 feet. Westport Chute remained unchanged in the upstream portion but widened from 600 feet to 1100 feet in the downstream portion. Because of the island growth down river of Westport Island, Westport Chute really extended to the end of Sterling Island in 1891.

Between 1821 and 1891, the chute between Cuivre Island at the Missouri mainland had narrowed from 800 feet to a width of 350 feet while elongating to 4.2 miles because Cuivre Island grew in the upstream direction.

By 1891, the backwater areas on the Illinois floodplain in the Pool 24 had been isolated by the Sny levee. Also, this levee closed off some of the side channels along the Illinois bank.

For more than a century, levees have been used in the Upper Mississippi River Basin to protect the people and floodplain property from floods. By 1891, there were more than 40 miles of levee along the Upper Mississippi River bank in the study reach.

The longest levee in 1891 was the Sny levee that extended along the Illinois side of the Mississippi River from opposite Slim Island (RM 264.5) on upstream past the location of Lock and Dam 22 (RM 301.2). Other levees were not so extensive. On the Missouri floodplain in the Pool 25 reach some individual fields were protected by levees. Otherwise, the Missouri floodplain in the study reach was mostly unprotected.

The effects of the levees on the river system are usually twofold. First, sedimentation on the floodplain is arrested because the floodplain is inundated only when the levees fail or are overtopped. Second, the storage capacity of the floodplain is no longer available to help attenuate flood peaks.

In the study reach of the Upper Mississippi, sedimentation on the floodplain due to flooding in the river was not significant in general. The amount of flood peak attenuation lost because of levee construction is difficult to estimate. The ratio of the floodplain storage volume to the volume of water in the peak of the flood hydrograph is the important factor. If this ratio is large, the levees are important and if this ratio is small, the levees are not a factor.

In the early stages of development the levees were not adequate to withstand large or long floods. Prior to 1891, at

least three sections of the Sny levee in the study reach had been breached. The crevasses were in sections opposite Carroll Island, at River Mile 290 (called the Blackwood Bend Crevasse) and 1.5 miles below the location of Lock and Dam 22.

The effects of the levees on river behavior is considered later in history when the levees were upgraded to withstand large peak flows.

Water discharge records in the study reach begin just 10 years or so prior to 1891. The water discharges in this period are not distinguishable from those recorded in later years.

No sediment measurements were made, but the transport capacity of the 1891 river channel in the Pool 25 reach has been estimated by using Toffalele's Method (1969). The sand transport rate was approximately 2,800,000 ton/yr. for the 1878-1964 flow duration curve. This rate is 13 percent greater than the rate computed for the early 1800's channel. In 1891 the average riverbed width in the Pool 25 reach was 3820 feet.

In summary, in 1891, the study reach of the Upper Mississippi River had many more islands than 70 years previously, resulting in many new side channels. In the Pool 25 reach, there were 50 islands, twice as many as in the early 1800's. Twenty-six percent of the surface area of this river reach was island area in 1891. The river had narrowed 200 feet in the Pool 25 reach, mostly in the upstream half. Some of the old long chutes in the Pool 25 reach changed in width or length and some did not. The sand transport capacity of the reach was approximately 2,800,000 tons/yr. In the Pool 24 reach, the Illinois floodplain had been isolated from the river by the Sny levees cutting off some side channels and backwater areas from obtaining surface flow from the river.

2.1.2.3 The Six-Foot Channel Project

As anticipated in 1878 it would soon be desirable to increase the depth of the Upper Mississippi River navigation channel between the Missouri River and St. Paul to a minimum of 6 ft. In the River and Harbor Act of March 3, 1905, Congress authorized the Secretary of War to:

> ...cause an estimate to be made of the cost of securing a channel 6 feet deep in that portion of the river above described.

On March 2, 1907, Congress inaugurated the 6-ft. channel project by authorizing an expenditure of 1.5 million dollars to be spent in the next three years.

The Secretary of War had outlined the work required to achieve a 6-ft. channel in a letter to Congress in 1906

(House Doc. 341, December 20, 1906). In the reach of river between Hannibal, Missouri and the Missouri River confluence, the Mississippi River was to be contracted in width using wing dams to obtain the desired depth. The proposed channel widths were 1200 ft. from Hannibal to the Illinois River and 1400 feet from the Illinois River to the Missouri. It was estimated that 10 years would be required to complete the work.

Along with the appropriation for capital works, the Congress set aside $50,000 for each of two years for dredging in harbors and landing places.

By 1905, a considerable expenditure in funds had been made in the reach of the Mississippi River between Hannibal and the Missouri River. Apparently though, a 4-1/2 ft. channel had been achieved. The total length of the wing dams constructed between 1878 and 1905 in the reach was 291,000 ft. requiring nearly 1,000,000 cu. yd. of rock and 1,400,000 cu. yd. of brush. In addition 238,000 lineal ft. of shore protection had been constructed requiring 470,000 and 440,000 cu. yd. of rock and brush respectively (House Doc. 341, 1906, p. 17).

The additional materials required for the 6-ft channel project between Hannibal and the Missouri River were 857,000 cu. yd. of rock and 4,100,000 cu. yd. of brush. The estimated cost of obtaining and placing these materials was $2,717,391 (House Doc. 341, 1906, p. 17).

An example of the extent of dike construction in the study area is illustrated in Figure 2-13. In the figure, the locations of the 127 dikes, which have been constructed in Pool 25, are shown. In this 31- mile reach of river, more than 22 lineal miles of dikes were built in the period between 1879 and 1929.

In the Illinois River system, a 7-ft. channel project was 95 percent complete from the mouth of the river to the canal at La Salle. In addition to the locks and dams at La Grange near Chicago and Kampsville, locks and dams were constructed with state funds to complete the Illinois Waterway. Also, since 1900 water had been diverted into the Illinois River from Lake Michigan through the Chicago drainage canal (Starret in Oglesby et al., 1972).

In 1930, when the 6-ft. channel project in the Upper Mississippi River was 82 percent complete, the 9-ft. channel was authorized. In order to prepare estimates of the cost of the 9-ft. project a new hydrographic survey was made in 1929-1930. The maps of this survey are known as the "Brown" maps, because they were prepared by W. N. Brown, Inc., Washington, D.C. under contract with U.S. Engineer Office, Rock Island, Illinois.

These maps show geomorphic features of the Upper Mississippi River when the 6-ft. channel project was terminated.

In general, the positions of the Upper Mississippi and Illinois Rivers in the study reach did not change in the period between 1891 and 1929. For example, the 1929 banklines of the Upper Mississippi River in the reach that is now Pool 25 are shown in Figure 2-14. By comparing this map with the 1891 map shown in Figure 2-12, two significant changes in the Illinois bankline are noted. Immediately upstream of Mosier Island, a small island (Island No. 474 on the 1891 map) became attached to the Illinois floodplain. Opposite Stag Island, the large island called Maple Island in 1891 also became joined to the Illinois floodplain by 1929.

The surface areas of the Pool 25 reach of the Upper Mississippi River in 1929 were measured on the 1929 topographic map and are given in Table 2-7. In the period between 1891 and 1929, the number of islands grew from 50 to 65 and the surface area of the islands increased by 2.304 sq. miles, an increase of 30 percent.

Table 2-7

Surface Areas of the Mississippi River in 1929

Location	Surface area, sq. mi.		
	River	Islands	Riverbed
Pool 25:			
Lower quarter	6.834	2.142	4.692
Middle half	14.972	4.738	10.234
Upper quarter	7.744	3.094	4.650
	29.550	9.974	19.576

As shown in Table 2-8, the five islands listed for the Pool 25 reach all grew in size. The growth of Mosier Island is shown in Figure 2-15. Significant deposition occurred on the downstream end and slight erosion occurred at the nose of the island. However, in other reaches some islands decreased in area.

The increase in the number of islands was the result of building wing dams. The river moves sand into the wing dam fields and creates sandbars. When these bars grow to a sufficient height, land vegetation takes hold and the sandbars become islands. For example, the dike (wing dam) field constructed

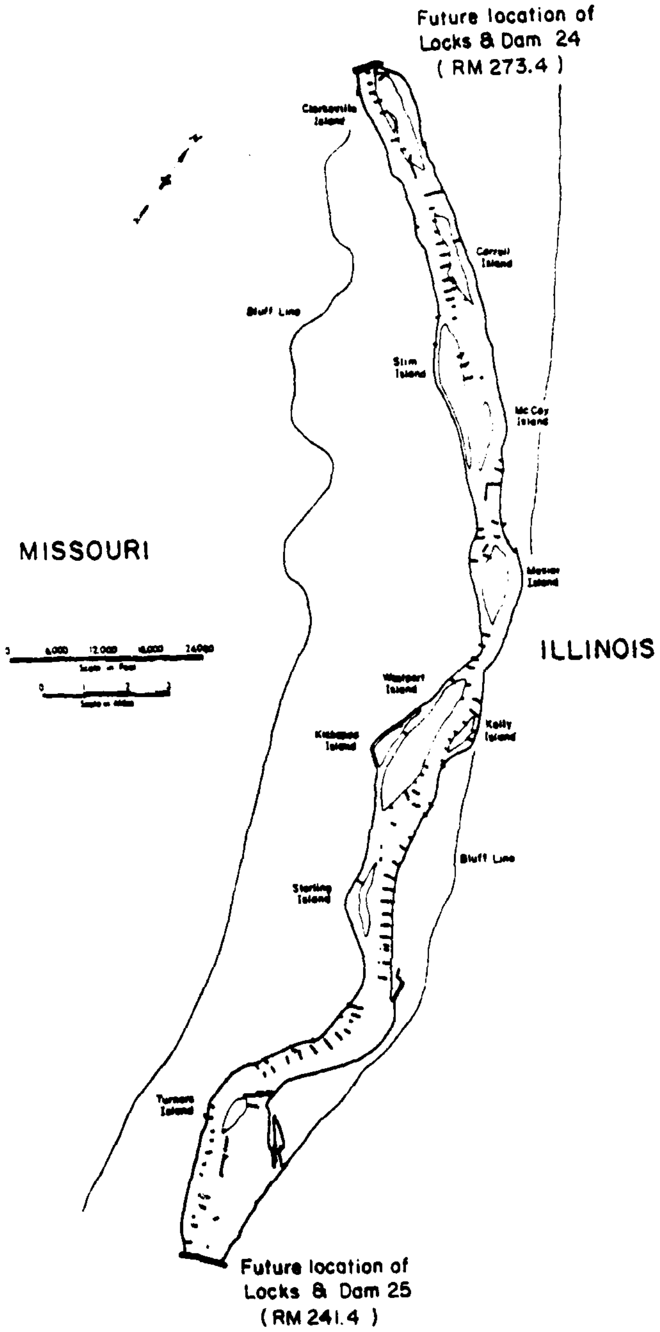


Figure 2-13 Location of dikes in Pool 25, Mississippi River

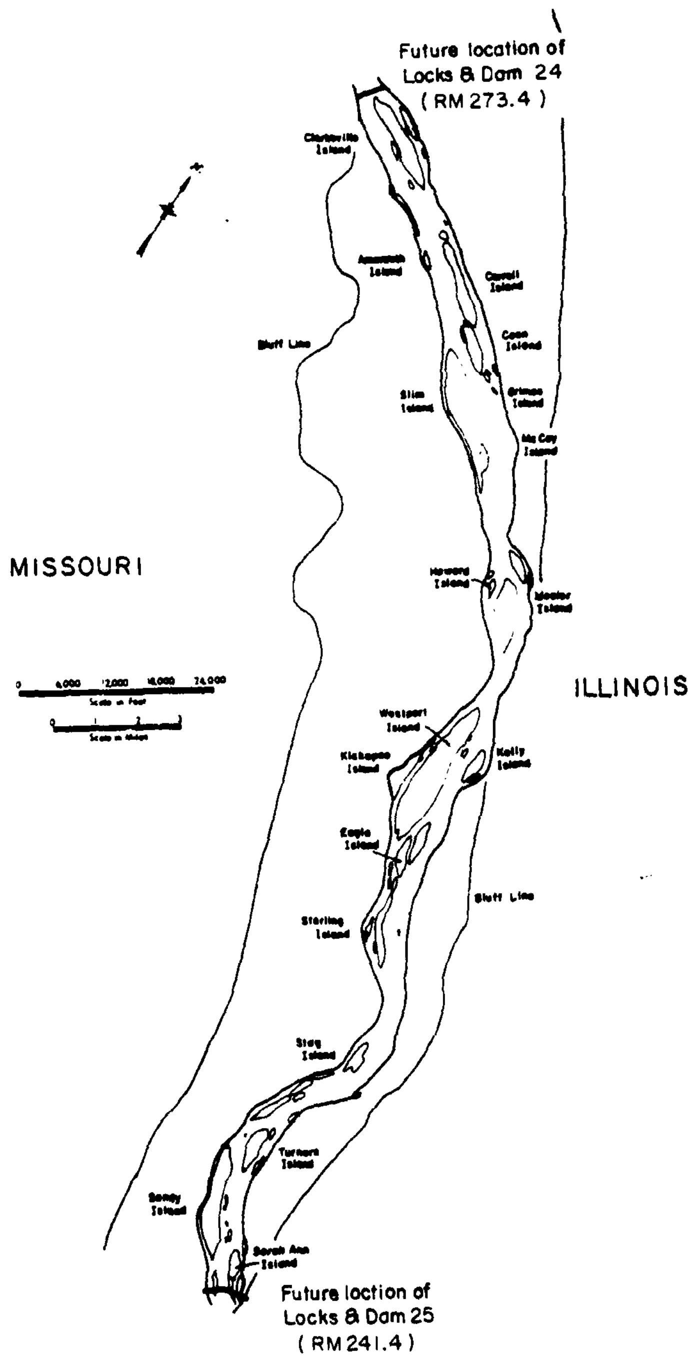


Figure 2-14 Map of the Pool 25 reach of the Mississippi River in 1929

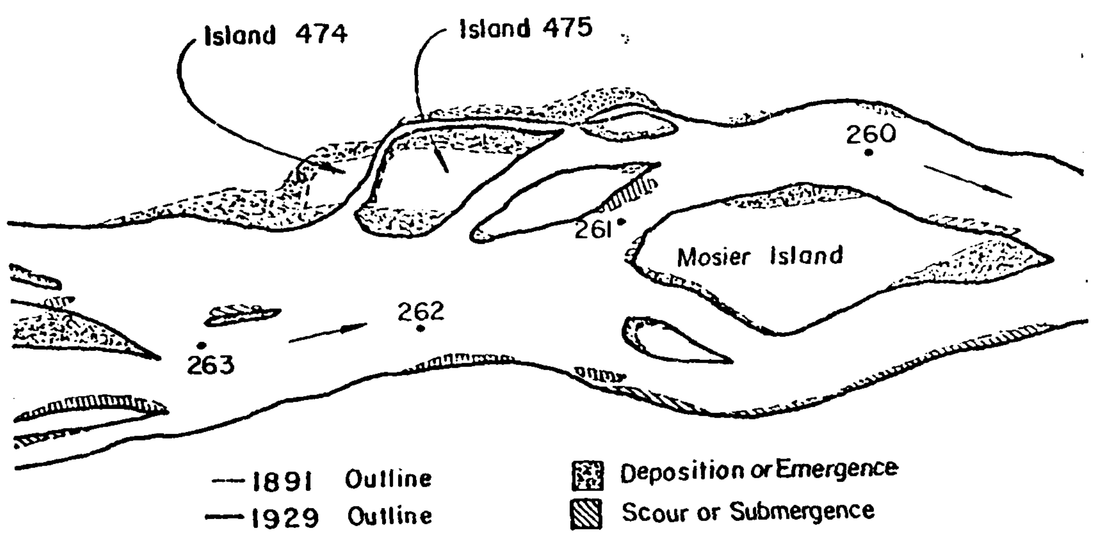


Figure 2-15 Mosier Island Reach

along the east side of Sandy Island between 1891 and 1929 produced five new small islands.

When wing dams are used to close chutes, sometimes islands form in the chute. This occurred in Westport Chute where two very small islands formed between 1891 and 1929.

Table 2-8

Changes in Islands

Name	Approx. River Mile	Surface area, sq. mi. 1929	Change since 1891
Pool 26:			
Piasa	209	-	-
Mason	220	.454	+.114
Sweden	234	.051	-.005
Peruque	234	.490	+.104
Cuivre	236	2.160	-.020
Pool 25:			
Turners	245	.370	+.167
Mosier	260	.654	+.177
Coon	267	.253	+.063
Carroll	268	.439	+.011
Clarksville	272	.899	+.375
Pool 24:			
Crider	279	.144	-.021
Unnamed	280	.104	-.084

Wing dams anchored landward to islands usually result in new sand deposits around and at the downstream ends of the islands. In time these deposits build to a height such that the land vegetation encroaches on the bars. Thus the islands grow in size. During the period between 1891 and 1929 many islands in the Pool 25 reach grew this way.

As a consequence of islands growing and small decreases in river widths between 1891 and 1929, the riverbed area in the Pool 25 reach of the Upper Mississippi River decreased by nearly 2.9 sq. miles.

The average surface widths of the Pool 25 reach in the Upper Mississippi River in 1929 are given in Table 2-9. The average surface width of the Mississippi River in the entire Pool 25 reach was 5030 ft., a decrease of 100 ft. since 1891.

Most of the narrowing of the river between 1891 and 1929 was due to the attachment of Maple Island and Islands 474 and 475 (Figure 2-15) to the Illinois floodplain.

Table 2-9

Average River Surface Widths in the Pool 25 Reach of the Upper Mississippi River in 1929

Location	Surface Width ft.
Pool 25:	
Lower quarter	4660
Middle half	5100
Upper quarter	5280

The 1929-1930 Brown survey maps included data from the hydrographic survey of the Mississippi River in the study reach. The average riverbed elevations for the reaches that are now Pools 24, 25 and 26 are given in Table 2-10. The averages are for the deepest 1000-ft. wide cross section of river.

In all reaches except the middle half of Pool 24, the riverbed elevation was higher in 1929 than in 1891. That is, over this period of 38 years the net effect was a slight aggradation in the deepest part of the channel. In contrast, during the period of wing dam construction in the Middle Mississippi River between St. Louis, Missouri and Cairo, Illinois, riverbed degradation resulted (Simon et. al., 1974, p. 19).

Table 2-10

Average Riverbed Elevations in the 1929 Mississippi River

Location	Riverbed Elevation,* ft. Amsl 1929	Change since 1891
Pool 26:		
Below Illinois River	--	--
Middle third	401.5	+1.7
Upper quarter	405.2	+1.3
Pool 25:		
Lower quarter	410.1	+0.4
Middle half	417.1	+0.1
Upper quarter	423.5	+1.2

Table 2-10 (con't)

Average Riverbed Elevations in the 1929 Mississippi River

Location	Riverbed Elevation,* ft. Amsl 1929	Change since 1891
Pool 24:		
Lower quarter	426.8	+1.3
Middle half	430.5	-0.2
Upper quarter	436.6	+1.5

* Average of the riverbed elevations in the deepest 1000-ft. width of river channel.

With the creation of new islands, there were more side channels in the study reach of the Upper Mississippi River in 1929 than in 1891. The 1929 chutes in the Pool 25 reach are shown in Figure 2-14 and the 1891 chutes in Figure 2-12. Each new island creates at least one more side channel. However, some chutes were filled up during the same period. For example, as shown in Figure 2-15, the chutes between Islands 474 and 475 and the Illinois mainland were closed.

Two of the three long chutes in the Pool 25 reach did not change much between 1891 and 1929. Sandy Chute remained 400 feet wide and 3 miles long. Slim Chute remained the same length but narrowed slightly from an average width of 530 feet to 480 feet. Westport Chute decreased in width to 830 feet from (1100 feet) and was due to the lateral growth of Kickapoo and Westport Islands. The increase in length occurred because Westport Island grew 0.2 miles in the upstream direction.

By 1929, improvements had been made to the Sny levees protecting the Illinois floodplain from the Mississippi River in the Pools 24 and 25 reaches.

On the Missouri side, levees were built along the bankline from Bobs Creek (RM 239) up along the Pool 25 reach of river to the bluff line near Clarksville, Missouri. Also, a small section of Missouri floodplain immediately upstream of the Salt River confluence was protected. In the Pool 26 reach, there were a few miles of levees back away from the river near Dardenne Creek and the Cuivre River.

One consequence of building levees was that many creeks on the floodplain were channelized. Bobs Creek below Lock and Dam 25 is one example and Kiser Creek in the SNY levee district is another.

Rubey noted in 1929 that both the Mississippi and Illinois Rivers flowed between natural levees and that the levees

of the Illinois are higher than those of the Mississippi. According to Rubey (1952,p. 123), it is probable that the height of the natural levees is a function of the permanence of the river channels. That is, along the Illinois River the natural levees have grown high by repeated additions of sediment in one place; whereas those along the Mississippi River are less high because the riv er has been more active. Through geologic time, the Upper Mississippi has shifted laterally, thereby destroying the natural levees on one side of the channel and abandoning them on the other.

Major differences between the Upper Mississippi and Lower Illinois Rivers were observed in 1929 by Rubey (1952, pp. 99, 101, 125). At that time he noted that the Illinois River was not actively eroding its banks. He also found that very few changes in Illinois River islands occurred between 1842 and 1929. This was in contrast to the Mississippi which shifted its channel "somewhat at each flood" with new bars forming and old ones being eroded.

The great difference in the type and amount of sediment load transported by the two rivers, as reflected by their gradients, provides an explanation of the disparity in morphology and behavior. The Illinois River has a gradient of 0.1 ft. per mile between Kampsville, Illinois and its mouth; whereas the Mississippi River between Quincy, Illinois and the mouth of the Missouri River has an average natural gradient of 0.6 ft. per mile.

In addition, the width-depth ratio of the Illinois River channel is about a third of that of the Upper Mississippi (Rubey, 1952, p. 128). Both the low gradient and the small width-depth ratio of Illinois River indicate that it is not transporting large quantities of sand. The suspended fine load transported through the gentle, narrow, deep channel at low velocities has not caused significant modification of the Illinois channel through time.

The low gradient of the Illinois River can also be related to Pleistocene events in the Mississippi and Illinois valleys, when large discharges and sediment loads of the Mississippi caused backwater effects and deposition in the Illinois Valley. The evidence for ponding was described by Rubey (1952, p. 96), and the ponding explains the flat gradient of the Illinois Valley and, in turn, the low sinuosity (approximately 1.1) and relative stability of the Illinois River.

By 1929, nearly 50 years of record had been gathered at the discharge gaging stations at Keokuk, Iowa and Alton, Illinois. No discharge measuring stations had been established yet on the Lower Illinois River.

Of the top-ten flood peaks recorded in the Upper Mississippi River at the Keokuk, Iowa station, six occurred prior to 1929. Ranking these in order from one as the highest to ten as the lowest, these six peaks were 1,4,5,6, 8 and 9. At the Alton, Illinois station, six of the ten largest flood peaks of record also occurred before 1929. Those ranked 1,2,4,6, 7 and 8. In the lower Illinois River at Meredosia, Illinois, the fourth and sixth highest stages of record were obtained in 1926 and 1927.

In conjunction with the topographic and hydrographic surveys, borings were made into the alluvium on the bed of the Upper Mississippi River at the proposed locations of the locks and dams in 1929-1930. At the proposed site of Lock and Dam 24 (RM 255.3), the alluvium under the bed of the main channel was almost entirely sand with a few lenses of clay and sand or mud and sand. As yet however, no sediment discharge measurements were made.

Based on the geometry of the 1929 Mississippi River channel in the Pool 25 reach, the sand transport of the channel has been estimated at 3,100,000 tons/yr. for the long term flow duration curve. This rate is 11 percent greater than the estimated rate for 1891. In 1929 the average riverbed width in the Pool 25 reach was 3330 ft.

In summary, the development of the 6-ft. navigation channel using the method of contraction with low wing dams did not affect the river morphology greatly. In the Pool 25 reach of the Upper Mississippi River, 15 new islands were created and a slight narrowing of the river occurred. In 1929, the average surface width of the river in this reach was 5030 ft., 100 ft. less than in 1891. The size of the islands in this reach increased by 30 percent between 1891 and 1929 and most of the large chutes remained unchanged.

The average riverbed elevations in the study reach of the Upper Mississippi River were slightly higher (0.8 ft. on the average) than in 1891 indicating that the deepest part of the river aggradated during the period of dike construction. This is opposite to the situation in the Middle Mississippi River where the construction of high dikes produced degradation of the riverbed (Simons, et. al., 1974). The sand transport capacity of the Pool 25 reach was approximately 3,100,000 tons/yr.

By 1929, both the Missouri and Illinois floodplains in the Pools 24 and 25 reaches had been protected by levees along the riverbanks. A portion of the Missouri floodplain in the Pool 26 reach was protected with levees in a few areas back from the river.

2.1.2.4 The Future

Researchers at Colorado State University were asked to build a mathematical model to predict the geomorphic changes in the study area 50 years from now with present day operations. It is concluded that the rivers will be essentially as they are today.

The anticipated riverbed elevation changes in the study reaches in the next 50 years are given in Tables 2-11 and 2-12.

Table 2-11

Future Riverbed Elevation Changes

in the Upper Mississippi River

Location	Riverbed Elevation Change since 1975, * ft. 1985	1995	2005	2015	2025
Pool 26:					
Below Illinois River	-1.1	0.4	0.2	0.6	0.6
Middle third	0.2	0.5	0.3	0.4	0.2
Next eighth	3.5	2.8	2.2	1.8	1.2
Upper eighth	-1.9	-3.7	-4.9	-6.0	-6.7
Pool 25:					
Lower quarter	-0.9	-0.7	-1.1	-1.1	-1.0
Lower middle quarter	0.1	-0.9	-0.3	-0.3	-0.2
Upper middle quarter	0.0	1.0	1.5	1.8	1.9
Next eighth	1.9	1.9	2.3	3.0	3.2
Upper eighth	-2.0	-2.7	-1.3	-2.6	-3.0
Pool 24:					
Lower quarter	0.1	1.1	0.7	0.7	0.3
Lower middle quarter	1.1	0.7	-0.5	-1.1	-1.2
Upper middle quarter	-0.2	-1.8	-2.8	-2.7	-2.7
Upper quarter	-1.5	-0.7	-1.1	-2.1	-2.4

* Positive changes signify aggradation and negative changes degradation of the riverbed.

In the upper half of Pool 24, the riverbed degrades until year 2000 and remains essentially unchanged thereafter. The maximum bed degradation is 2.5 feet below 1975 riverbed level. In the earlier years, the flow in the upper reach has capability to carry more sediment than is released from Pool 22. Channel erosion results enlarging the river cross-section, which in turn reduces the flow velocity and the sand transport capability of the upper reach. After years of degradation, the channel conditions of the upper reach approach equilibrium. In the

meantime, bed degradation begins slowly in the lower half of Pool 24 after 1995 and causes its aggraded bed to degrade.

Table 2-12

Future Riverbed Elevation Changes

in the Lower Illinois River

Location	Riverbed Elevation Change since 1975,* ft. 1985	1995	2005	2015	2025
Lower third	0.1	0.2	0.3	0.3	0.4
Middle third	0.1	0.1	0.2	0.3	0.3
Upper third	-0.2	-0.6	-1.0	-1.3	-1.5

* Positive and negative changes signify aggradation and degradation respectively.

In Pool 25, 3 feet of degradation occurs below Dam 24 in 50 years. Downstream of this degraded reach there is a reach of braided channel where the sediment transport capability is small. In this braided reach, 3 feet of bed aggradation is anticipated in the next 50 years.

It should be pointed out that the riverbed generally fluctuates with time as the sandbars move downstream. Sediment may deposit on the riverbed during low or medium flow but the deposited sediment may be eroded away during the high flow or vice versa. In general however, the crossing areas accumulate sediment easier than the other portions of the river reach. Therefore, at crossings the bed elevation fluctuates with a trend toward aggradation. The opposite occurs in the deep part of the channel bends.

In the lower half of Pool 25, the riverbed degrades until year 2000 because large amounts of sediment are being trapped in the upper reach. After year 2000, the upper reach approaches the equilibrium state and passes more sediment load which stops the degrading of the lower reach.

In Pool 26, the riverbed immediately downstream of Lock and Dam 25 degrades for the entire 50 years. The lower end of the pool aggrades 3.5 feet within 10 years, then aggrades more slowly for a while and finally begins to degrade.

In the Illinois River, the sediment transport rates are small because the river gradient is very small. As shown in Table 2-12, 1.5 feet degradation and 0.4 feet aggradation are expected in year 2025 in the upper third and lower two-thirds reaches, respectively.

2.1.3 SOILS

2.1.3.1 Introduction

The alluvial valleys of the study area are mantled with various surficial materials which occupy several different positions on the floodplain. Each soil type has a distinctive character developed in accordance with its topographic position and parent material. It is the purpose of this section first, to provide general soil maps of the floodplains in the study area by combining several soil types with similar characteristics into the soil units which appear on the maps and second, to briefly describe some of the physical properties and land use capabilities of each soil group. (See Plate 3, A-D).

A data base was established for this study using individual county soil surveys published by the Soil Conservation ervice, U.S. Department of Agriculture. Classification of soil types varies on a county by county basis due to the date of the survey, and the state conducting the survey. Surveys published before 1938 use the Descriptive Name classification and post-1938 surveys use the Soil Series classification system. Series names, however, may vary over an area which includes more than one state due to each state using its own series names. Because of the wide range of legends in the data base, each county report was converted to the new Soil Taxonomy system to simplify correlation of soil types and selection of a comprehensive legend.* Due to the limitations of scale for publication, soil units were mapped at the Great Group level. Thus, the soil maps show only the general character of the distribution of soil units within the alluvial valleys of the study area.

On site detailed soil maps would be necessary prior to any overbank disposal of dredged material.

The alluvial valleys of the study area are composed of differential earth materials which are found in five basic positions on the floodplain (Figure 2-16). These materials are listed and discussed as follows: (1) Materials found at the foot of the bluffs consist of reworked loess, fragments of bedrock, and eroded glacial till from the uplands. Alluvial and colluvial materials may be deposited either as fans where tributary streams enter the main valley or as loose and incoherent deposits at the foot of the bluffs. The soil which develops on these deposits is usually coarse in texture, has good drainage, and is moist but not wet. (2) Terraces, which are remnants of older, higher floodplains, are also found adjacent to the bluffs or may

* (See: Soil Conservation Service, 1972, Soil Series of the United State, Puerto Rico; and the Virgin Islands: Their Taxonomic Classification, 360 pp.)

BASIC SOIL POSITIONS ON THE FLOODPLAIN

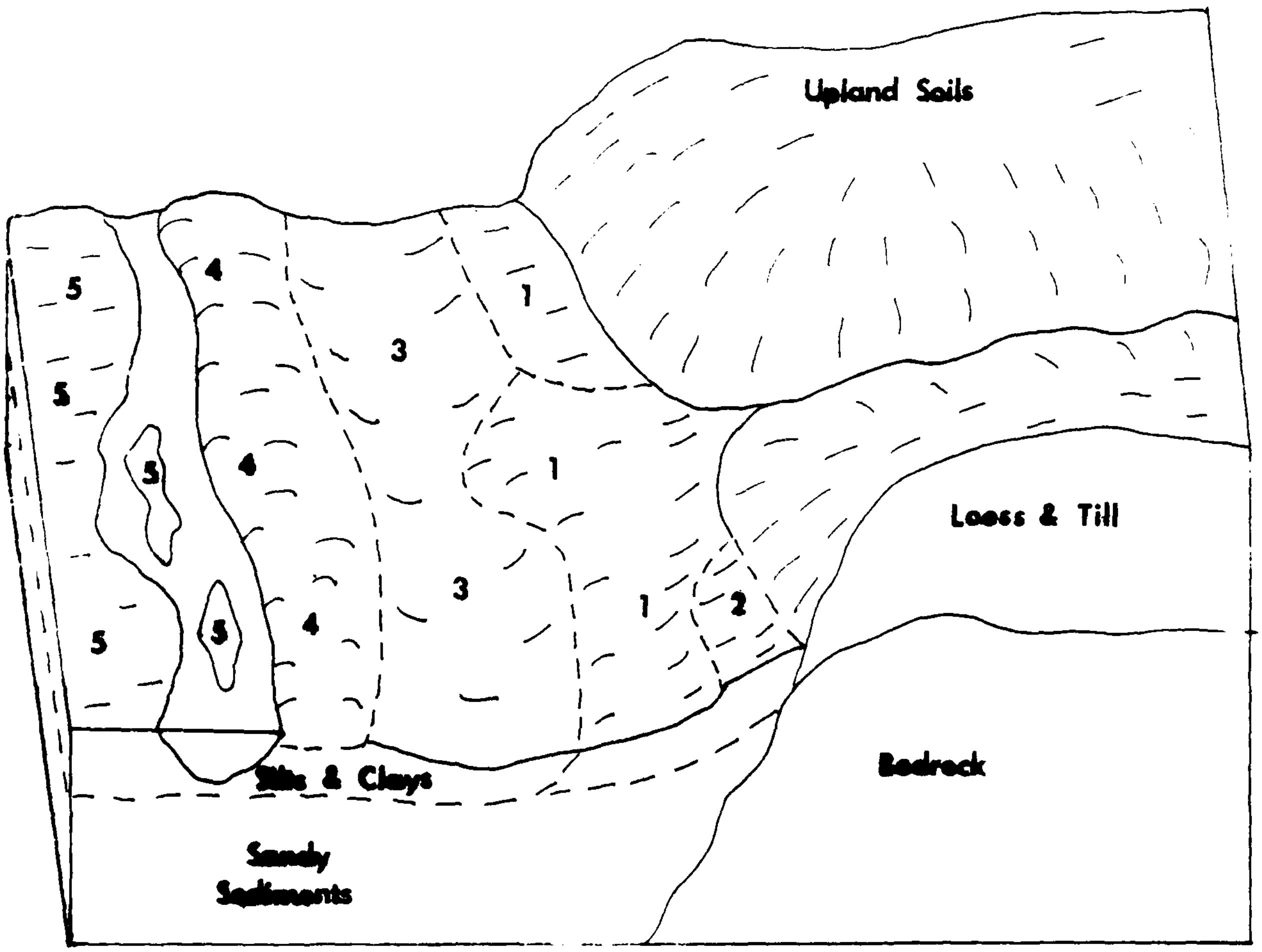


Figure 2-16

occur as isolated highs in the floodplain. These "high bottoms", or "second bottoms" as they are sometimes referred to, may be remnants of Pleistocene sands and gravels which were deposited as glacial streams aggraded. Some terraces may be of more recent deposition. These usually consist of finer sediments that are not as well drained as the sandy Ice Age terraces. (3) Low areas, such as depressions, old water courses, and sloughs are also found on the floodplain. "Gumbo" is the common name for the soil found in these areas which is usually high in clay content and very wet. (4) Higher areas, such as natural levees, sand bars, and old islands may also be found in the alluvial valleys of the study area. The soils in these areas are composed mainly of sands and silts and are usually moist but not wet. (5) Islands and lowlands adjacent to the river are areas of recent deposition. The materials found in these locations are generally wet, but otherwise highly variable and may change their geographical extent and depth with each flood.

2.1.3.2 Soil Distribution

Plate 3, A-D, provides a view of the geographical distribution of the eight soil units mapped in the alluvial valleys. Some of the five basic floodplain positions have more than one soil unit representing the topographic position. These additions reflect differences in soil texture and native vegetation.

The following is an abbreviated description of each soil unit found in the alluvial valleys of the study area. For a more complete explanation of the soil series found in each soil unit, representative soil interpretation sheets are provided in Appendix A-1.

a. <u>Soil Unit I (Hapludalfs)</u>. These soils were mapped as several small terraces throughout the study area. They are well-drained because of their loamy texture, and though low in organic material they are good for crop production. Limitations are slight for most construction and/or recreational uses.

b. <u>Soil Unit II (Ochraqualfs)</u>. This unit is low in organic material and very wet. They are found on a few ill-drained terraces throughout the study area. Crop production is satisfactory if managed properly. Structural and recreational uses are limited due to seasonal high water tables.

c. <u>Soil Unit III (Albaqualfs)</u>. These are old terrace soils with very poor drainage due to a subsoil horizon which holds the wetness. Albaqualfs are well suited to agriculture when adequately drained and properly managed. Limitations for construction and recreational uses are severe due to poor surface drainage and slow permeability. A few of these old terraces are located throughout the study area.

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d. Soil Unit IV (Udifluvents). These soils are found as alluvial and colluvial fans extending from the base of the bluffs and on many high areas throughout the bottoms. They are composed of recent alluvium and are moist but not wet. Because of this and their slightly elevated positions these are excellent agricultural soils. These soils are, however, subject to freshlet flooding which places severe limitations on other land uses with the exception of suitability for wildlife.

e. Soil Unit V (Fluvaquents). Fluvaquents are highly variable soils composed of recent alluvium. This soil unit is one of the major soils of the study area and includes most islands, low areas adjoining streams, and bottomlands subject to frequent inundation. Fluvaquents are very wet soils, but if drained and protected from flooding they provide excellent agricultural soils. If left in a natural condition, however, fluvaquents are best suited for wildlife habitat.

f. Soil Unit VI (Hapludolls). These soils comprise a major soil unit in the study area. Hapludolls are found on natural levees, high bottoms, and alluvial fans. They are usually of a loamy texture and are subject to floods of short duration. These soils are well suited for agricultural purposes when properly drained and protected from inundation. In a natural condition they are suited for wildlife. Other uses have moderate to severe limitations due to seasonally high water tables and flooding.

g. Soil Unit VII (Haplaquolls). Haplaquolls that are poorly drained soils with a high clay and organic material content. These soils are widespread in the study area occupying low and depressional areas of the floodplain. They are difficult to manage for agricultural purposes for they are wet and usually ponded after precipitation and when dry have a hard brick-like surface with deep cracks. They are poorly suited and have severe limitations for almost all uses other than wildlife propagation.

h. Soil Unit VIII (Argiudolls). These soils are formed on a few somewhat poorly drained sandy terraces from alluvial deposition throughout the study area. Argiudolls provide fairly good yields for row crops but, are subject to inundation and seasonal high water tables. Moderate to severe limitation factors must be considered for uses other than agricultural and wildlife habitat.

2.1.3.3 Soil Productivity

The alluvial soils of the study area for the most part produce high agricultural yields provided they are under a high level of management (Table 2-14). This management would in many cases include artificial drainage and often protection from

inundation. Under these conditions soil units from these valleys will in most cases yield more per acre than the national average (Table 2-13).

The case in point, however, involves many areas in the floodplain which are neither adequately drained nor protected from inundation. Thus, when the soils are evaluated in a natural or semi-natural state they sometimes produce much lower yields. In many instances it would not be feasible to place some of floodplain areas under high levels of management by draining or providing protection from floods due to the shape, orientation, and topographic location of the given area. For instance, long narrow strips of land (between sloughs or along stream channels), or low areas subject to ponding could be questionable investments for any high expectations of agricultural production. On the other hand, a relatively large area uninterrupted by standing water may provide a good return if properly managed. Thus, production capacity and feasibility of development are relative to ownership and natural boundaries which determine the shape and orientation of the area under consideration.

Table 2-13

1973 National Average Agricultural Yields*

Corn	91.4 bu/acre	Soybeans	27.8 bu/acre	Wheat	31.8 bu/acre
Oats	47 bu/acre	Sorghum	58.8 bu/acre	Hay	2.2 bu/acre

Source: Table 623, Agricultural Statistics 1974, United States Department of Agriculture.

Table 2-14

Soils of the Study Area,
Average Agricultural Yields Based on a High Level of Management*

		Average Yields per acre					
Soil Unit	State	(bu) Corn	(bu) Soybeans	(bu) Wheat	(bu) Oats	(bu) Sorghum	(bu) Hay
I. Hapludalfs	Mo	75	32	35	--	62	3.2
	Ill	100	33	44	63	--	4.0
II. Ochraqualfs	Mo	78	29	32	--	67	3.5
	Ill	108	38	47	63	--	4.5
III. Albaqualfs	Mo	75	27	31	--	66	3.3
	Ill	95	34	42	60	—	3.8

Table 2-14 (con't.)

Soils of the Study Area,
Average Agricultural Yields Based on a High Level of Management*

Soil Unit	State	Average Yields per acre (bu) Corn	(bu) Soybeans	(bu) Wheat	(bu) Oats	(bu) Sorghum	(bu) Hay
IV. Udifluvents	Mo	107	40	45	67	100	4.1
	Ill	115	40	30	70	--	4.8
V. Fluvaquents	Mo	98	36	48	--	--	4.3
	Ill	108	38	46	--	--	4.5
VI. Hapludolls	Mo	118	44	48	--	105	5.0
	Ill	125	44	53	77	--	5.3
VII. Hapluquolls	Mo	97	37	43	--	80	3.7
	Ill	108	39	46	70	--	4.2
VIII. Argiudolls	Mo	90	41	38	--	77	3.8
	Ill	133	47	54	83	—	5.4

* Source: Soil Interpretation Sheets, S.C.S.

2.1.4 WATER QUALITY

The description of water and sediment quality in navigation Pools 24, 25, and 26 of the Upper Mississippi River and lower 80 miles of the Illinois River is based on results of a study which was conducted by the U.S. Army Engineer Waterways Experiment Station. Presented here is information considered sufficient for the purposes of this environmental statement concerning selected physical and chemical characteristics of water and sediment samples collected from side channel, main channel, dike area, and river border habitats.

2.1.4.1. Water Temperature.

a. Mississippi River. Water temperature recorded at all four habitats showed the same trend, a general cooling between the July sampling period and September sampling period (Appendix B, Tables 1 through 4). Decreasing ambient air temperature during later summer cooled the water mass in all habitats studied. Slight differences in the mean temperature of surface waters among habitats were observed. Generally, during July, mean surface temperatures recorded in side channels (26.3°C) and dike areas (26.3°C) were slightly higher than those recorded for river border areas (25.9°C) and main channel areas (25.7°C). During September, decreasing ambient air temperatures cooled the surface waters in side channels more rapidly than at other habitats. During July, thermal stratification was most strongly defined in side channels. Temperature differences between surface and bottom strata in September among all habitats studied were minimal.

b. Illinois River. Water temperature of the Illinois River showed the same kind of variation which was observed for the Mississippi River, a general cooling between July and September (Appendix B, Tables 5 through 8). Significantly higher mean surface temperatures during July were recorded for the single dike area sampled. However, during the September sampling period, highest mean surface temperatures were recorded for river border areas. As observed for the Mississippi River, surface waters in side channels cooled more rapidly in September than at other habitats studied. During July, thermal stratification of the water column was most pronounced for river border areas and main channel habitats. Only slight differences between surface and bottom temperatures for all habitats were observed during September.

2.1.4.2. Dissolved Oxygen.

a. Mississippi River. Mean dissolved oxygen measured at the surface during July was essentially the same for dike areas (6.6 milligrams per liter, mg/l), river border areas (6.6 mg/l), and side channels (6.5 mg/l), but slightly higher for the main channel (6.8 mg/l) (Appendix B, Tables 1 through 4). Lower water temperature during September was probably the most significant factor which contributed to the observed increase in dissolved oxygen from July to September. The dissolved oxygen of surface waters recorded at all habitats was over 9.0 mg/l. The percent saturation of oxygen during July ranged from 75 to 85 percent. During September, oxygen saturation values were over 105 percent. For some of the side channels, oxygen profiles from surface to bottom strata followed thermal stratification patterns. During July, side channel habitats essentially were stratified with respect to dissolved oxygen. Mean surface dissolved oxygen was 6.5 mg/l; mean bottom dissolved oxygen was 5.1 mg/l. Slight differences in the oxygen content of surface and bottom strata were noted during September.

b. Illinois River. Dissolved oxygen concentrations of surface and bottom waters of all habitats studied followed the same trend observed for the Mississippi River, a general increase from July to September (Appendix B, Tables 5 through 8). Mean surface and bottom dissolved oxygen concentrations during July were essentially the same among all habitats indicating no stratification pattern. However, during the September period, stratification among side channels of the water column occurred. Mean surface dissolved oxygen was 8.6$\pm$0.3 mg/l, while the mean bottom was 8.1$\pm$1.2 mg/l.

2.1.4.3. Turbidity.

a. Mississippi River. Some distinct differences were observed among the habitats sampled during the July sampling period. Highest mean turbidity was recorded for main channel areas (282.3$\pm$117.7 Jackson Turbidity Units, JTU's) and adjacent river border areas (280.4$\pm$136.7 JTU's) (Appendix B, Tables 2 and 3). Next highest mean turbidity was observed for dike areas (248.0$\pm$108.9 JTU's) and lowest mean turbidity was associated with side channel habitats (215.9$\pm$128.6 JTU's) (Appendix B, Tables 1 and 4). A direct relationship between turbidity and current velocity was evident from examination of the data presented in the tables mentioned above. Turbidity increased as current velocity increased. Highest turbidity and current velocity (2.5 feet per second, fps) were observed for main channel areas while lowest turbidity and current velocity (1.2 fps) were observed for side channel habitats. Among the four habitats studied, differences in turbidity measured near the bottom of the water column followed the same trend observed for surface measurements.

Also, bottom turbidity was higher than surface turbidity. Increased turbulence near the bottom strata accounted for the increased turbidity over depth. Lower current velocity observed during September accounted for the reduction of turbidity measured at both surface and bottom strata between July and September (Appendix B, Tables 1 through 4). However, the trend observed during the high flow period (July) was essentially reversed during the low flow period (September). Mean surface turbidity during September was highest for side channels, 61.3 JTU's; followed by dike areas, 48.2 JTU's; river border areas, 40.0 JTU's; and main channel areas, 36.9 JTU's. Since concentrations of settleable solids during September for all habitats were essentially the same, turbidity differences among habitats is most likely attributable to differences in standing crops of plankton.

b. Illinois River. Among those habitats studied in the Illinois River, mean surface turbidity in July was highest at the single dike area, 160.0 JTU's; followed by river border areas, 147.3 JTU's; main channel areas 144.5 JTU's; and side channels, 122.0 JTU's (Appendix B, Tables 5 through 8). Highest current velocity was associated with the highest turbidity observed at the dike area. Bottom turbidity exceeded surface turbidity in all habitats sampled during July; presumably caused by increased turbulence nearer the bottom. During September the Illinois River carried less suspended matter due to reduced current velocities (Appendix B, Tables 5 through 8). Similar to the observations made in July, mean surface turbidity was greatest at the single dike area (115.0 JTU's) and river border areas (95.0 JTU's). The difference in mean surface turbidity between main channel areas (90.0 JTU's) and side channels (96.7 JTU's) was negligible during September. Larger standing crops of plankton probably accounted for most of the suspended matter measured as turbidity in side channels than in the main channel areas (Appendix B, Tables 5 and 6).

2.1.4.4. Settleable Solids.

a. Mississippi River. Settleable solids were measured volumetrically from water samples collected just below the surface at all four habitats. The results are presented in Appendix B, Tables 1 through 4. During the high flow period in July the mean concentration of settleable solids associated with main channel and river border areas was the same, 0.5 ml/l. The concentration measured at both dike areas and side channels was also identical, 0.4 ml/l. During reduced flow conditions in September, there were no differences among habitats for settleable solid concentrations. The mean concentration for all four habitats was 0.1 ml/l.

b. Illinois River. Concentrations of settleable solids measured among all four habitats in the Illinois River were remarkably similar (Appendix B, Tables 5 through 8).

Only during the high flow period (July) was there a difference observed among habitats. During July, the mean concentration associated with main channel areas was 0.2 ml/l; mean concentration for the remaining habitats was 0.1 ml/l. No differences in mean concentrations among habitats were observed during the low flow period (September). The mean concentration recorded for mean channel areas, dike areas, river border areas, and side channels was 0.1 ml/l.

2.1.4.5. Total Alkalinity.

a. Mississippi River. Measurements of total alkalinity made in the four habitats during July and September are presented in Appendix B, Tables 1 through 4. Mean surface and bottom total alkalinity were very similar for all habitats. During July, highest mean total alkalinity was recorded for side channels (surface = 140.8 mg/l, bottom = 142.8 mg/l) and lowest mean total alkalinity was recorded for the single dike area (surface = 133.5 mg/l. bottom = 134.9 mg/l). Total alkalinity measured at surface and bottom increased about 30 mg/l between July (high flow period) and September (low flow period). During September, highest mean total alkalinity was observed among side channels (surface = 159.3 mg/l, bottom = 161.1 mg/l) and lowest mean total alkalinity was recorded for the dike area (surface = 150.9 mg/l, bottom = 148.0 mg/l) although these differences were small. No phenolphthalein alkalinity was detected.

b. Illinois River. During the July sampling period mean surface total alkalinity was more similar between dike (164.0 mg/l) and side channel (161.3 mg/l) and between main channel 152.3 mg/l) and river border areas (149.1 mg/l) (Appendix B, Tables 5, 6, 7, and 8). Highest mean surface values were recorded for the single dike area and lowest mean surface values were recorded for river border areas. During the low flow period (September), mean surface alkalinities were similar for all habitats, ranging from 201.0 mg/l at the dike area to 196.3 mg/l at river border areas (Appendix B, Tables 5, 6, 7, and 8). Considering all habitats, surface alkalinities increased on the average of about 40 mg/l from July to September while bottom alkalinities increased about 60 mg/l from July to September. Differences in total alkalinity between surface and bottom strata were greater during July than during September. No phenolphthalein alkalinity was detected.

2.1.4.6. Nutrients (Water and Sediments).

a. Mississippi River. Nutrient analyses performed on water samples collected from five side channel and 12 main channel habitats during July 1974 showed concentrations of nutrients between the habitats to be similar (Appendix B, Tables 1 and 2).

Mean ammonia and nitrite nitrogen concentrations for both side channels and main channel areas were identical, 0.7 mg/l and 0.1 mg/l, respectively. Mean nitrate nitrogen concentration for side channels was 0.6 mg/l and for main channel areas 0.8 mg/l. Mean total phosphorus concentrations were also very similar for both habitats; 1.4 mg/l for side channels, and 1.3 mg/l for main channels. During September 1974, nitrate and nitrite nitrogen forms were not differentiated, but were reported as nitrate-nitrite nitrogen combined (Appendix B, Tables 1 and 2). Nitrate-nitrite concentrations for both main channels and side channels were similar, 1.0 mg/l and 0.8 mg/l, respectively. Mean total phosphorus concentration for both habitats was also identical, 0.2 mg/l. During September, ammonia nitrogen was higher in main channels (0.2 mg/l) than in side channels (0.06 mg/l).

Results of nutrient analyses performed on sediment samples collected from side channels and main channel areas during July are presented in Appendix B, Tables 1 and 2. All values are reported on the basis of dry weight. With one exception (total phosphorus), concentrations of all nutrient forms were higher in side channels than in main channel areas. Mean nitrate nitrogen concentration in side channels was 18.0 milligrams per kilogram (mg/kg); mean concentration in main channel areas was 13.3 mg/kg; mean nitrate nitrogen concentrations for side channel and main channel areas were similar, 2.2 mg/kg and 2.0 mg/kg, respectively. In side channels, mean ammonia nitrogen concentration (10.7 mg/kg) was more than twice the concentration observed in main channel areas (5.0 mg/kg). The mean concentration of total phosphorus observed was slightly higher in main channel areas (67.5 mg/kg) than in side channels (64.2 mg/kg). Conversely, the mean concentration of total Kjeldahl nitrogen (TKN) was higher in side channels (677.6 mg/kg) than in main channel areas (67.4 mg/kg). During September the mean concentration of total phosphorus was higher in side channels (535.9 mg/kg) than in main channel areas (187.1 mg/kg). The same trend was observed for total Kjeldahl nitrogen concentrations. Concentrations of TKN in sediments did not exceed the bulk sediment criteria proposed by the Environmental Protection Agency (EPA) (cited in Boyd, et al., 1972) except in one side channel (river mile 201.3) sampled in September.

b. Illinois River. Chemical analyses of water samples collected from the Illinois River during July and September 1974 are presented in Appendix B, Tables 5 and 6. During July, a period of high flow, identical concentrations of nitrite nitrogen and total phosphorus were observed for both main channel areas and side channels, 0.1 mg/l and 1.4 mg/l, respectively. Mean nitrate and ammonia nitrogen concentrations were higher in main channel areas (1.4 mg/l and 0.7 mg/l, respectively) than in side channels

(1.0 mg/l and 0.4 mg/l, respectively). During the low flow sampling period, September, mean concentrations of ammonia nitrogen and total phosphorus observed for both habitats were also identical, 0.1 mg/l and 0.5 mg/l, respectively. Combined nitrate-nitrite concentration was higher in side channels (2.8 mg/l) than in main channel areas (2.5 mg/l) during the low flow sampling period. None of the ammonia nitrogen concentrations exceeded the Illinois Water Quality Standards (State of Illinois E. P. A., 1972).

The concentration of nutrients measured in sediment samples collected from main channel areas and side channel of the Illinois River during July and September 1974 are presented in Appendix B, Tables 5 and 6. Of the various nutrient forms measured during July, only total phosphorus occurred in higher concentrations in main channel areas than in side channels. Mean concentrations of all other forms (nitrate, nitrite, ammonia, and total Kjeldahl nitrogen) were higher in side channels than in main channel areas. During September ammonia nitrogen and total phosphorus concentrations were identical in sediments collected from both side and main channel areas (0.1 mg/kg and 0.5 mg/kg, respectively). However, contrary to what was observed during the July sampling period, in September the mean concentration of total phosphorus was higher in side channels (705.0 mg/kg) than in main channel areas (392.4 mg/kg). Mean total Kjeldahl nitrogen concentration measured in the main channel areas during September was 348.0 mg/kg. Total Kjeldahl nitrogen measured in one side channel exceeded the proposed EPA criterion during September.

2.1.4.7. Metals (Water and Sediments).

a. Mississippi River. The results of metal analyses performed on water samples collected from side channels and main channel areas during July and September in the Mississippi River are presented in Appendix B, Tables 1 and 2. Analyses were performed for seven metals (arsenic, iron, manganese, lead, cadmium, zinc, and mercury) and cyanide. The analyses showed that concentrations of all metals, with one exception, were below maximum allowable concentrations based on Illinois Water Quality Standards. During July, mercury concentrations exceeded the Illinois Standard in four side channels and eight main channel areas; in September, the standard was exceeded again in four side channels and five main channel areas. Mean mercury concentrations in side channels during July and September were 0.0048 mg/l and 0.0015 mg/l, respectively. Mean concentrations detected during the same sampling periods in main channel areas were 0.00045 mg/l and 0.0008 mg/l, respectively. According to Illinois Standards the maximum allowable concentration of mercury is 0.0005 mg/l.

Sediments from side channels and main channel areas were also analyzed for those metals mentioned above (Appendix B, Tables 1 and 2). Concentrations of lead, zinc, and mercury were compared with bulk sediment analysis criteria by the EPA. Concentrations of lead and mercury in sediments collected from main channel areas during both July and September were below the proposed criteria based on percent dry weight. However, zinc concentrations exceeded the proposed criterion in two main channel areas during July; during September zinc concentrations did not exceed the criterion. Metal analysis performed on sediments from side channels revealed a similar trend. Concentrations of zinc exceeded the maximum allowable level in two locations during July, and in three locations during September. Mean concentrations of zinc during these periods were 93.7 mg/kg, and 60.7 mg/kg, respectively. Lead and mercury concentrations were below proposed criteria.

b. Illinois River. Metal analyses were also performed on water and sediment samples collected from five main channel areas and two side channels of the Illinois River. Results are presented in Appendix B, Tables 5 and 6. Concentrations of arsenic, manganese, lead, cadmium. and zinc in water samples collected from both side channels and main channel areas during July and September were all below the Illinois water quality standards. Mercury concentrations, however, exceeded the standard in two main channel areas during both sampling periods. The mean mercury concentration during July was 0.0032 mg/l; during September the mean concentration was 0.00102 mg/l. Concentrations of lead, zinc, and mercury, in addition to other metals, were analyzed in sediments collected from side channels and main channel areas during the study and these are presented in Appendix B, Tables 5 and 6. Lead and mercury concentrations did not exceed proposed EPA criteria during either sampling period. Conversely, zinc concentrations from both habitats were higher than the proposed criterion. During July four of the five main channel areas and both side channels sampled contained zinc concentrations that exceeded the criterion. During September zinc concentrations in sediments from two main channel areas and both side channels exceeded the maximum allowable value. The highest mean concentration of zinc was associated with side channels during July.

2.1.4.8. Pesticides (Water and Sediments).

During July 1974, detectable concentrations of organochloride pesticides were observed in sediment samples collected from side channels and main channel areas from the Mississippi or Illinois Rivers.

a. Mississippi River. During September, sediments collected from side channels and main channel areas were analyzed for the following organochloride pesticides: chlordane, dieldrin, DDE, DDD, and DDT. Also, analyses were performed for polychlorinated biphenyls (PCB).

analyzed for. Among main channel areas sampled on the Mississippi River, the only detectable compound was PCB. PCB concentrations ranged from 17 micrograms per gram (ug/g) to 57 ug/g and averaged 28.3 ug/g. Analyses of sediments collected from side channels during September indicated that all six pesticides mentioned above occurred in detectable concentrations. Chlordane ranged from 0.0 ug/g to 7.0 ug/g and averaged 2.57 ug/g. Dieldrin ranged from 0.0 ug/g to 10 ug/g and averaged 4.28 ug/g. Mean concentration of DDT was 3.14 ug/g and ranged from 0.0 ug/g to 6.0 ug/g. Mean concentrations for the remaining forms were: DDE (2.71 ug/g), DDD (7.85 ug/g), and PCB (61.42 ug/g).

b. Illinois River. Pesticide analyses of sediments collected from side channels and main channel areas during September 1974 showed detectable concentrations in both habitats. In every case, higher concentrations of pesticides were detected among side channels than among main channel areas.

2.1.4.9 Summary.

Generally speaking, differences in physicochemical variables between the Mississippi and Illinois Rivers were most noted among surface, bottom, and water column data categories. Analysis of surface physicochemical variables indicated that higher mean values for dissolved oxygen, turbidity, and pH were associated with the Mississippi River. Higher bottom temperatures were also observed for the Mississippi River. Mean total alkalinity concentrations were higher for the Illinois River for all depths sampled. Of those column physicochemical variables measured, only settleable solids was shown to differ between rivers with highest concentrations noted for the Mississippi River.

Fewer differences between rivers were noted for water and sediment chemistry variables. Of those water chemistry variables measured, only total phosphorus differed significantly between rivers. Sediment chemistry variables which differed included ammonia nitrogen, total phosphorus, and iron. In all cases, the means of both water and sediment chemistry variables were noted to be greater for the Illinois River than for the Mississippi River.

In one side channel on the Mississippi River and one side channel on the Illinois River during September total Kjeldahl nitrogen was found in the sediments to exceed the proposed EPA criteria. During July, mercury concentrations in the water of the Mississippi, exceeded the Illinois Standard in four side channels and eight main channel areas; in September the standard was exceeded again in four side channels and five main channel areas. Zinc concentrations exceed the proposed criterion in the water from two main channel areas during July. In sediments from side

channels concentrations of zinc exceeded the maximum allowable level in two locations during July, and in three locations during September. In the Illinois River mercury concentrations in the water exceeded the standard in two main channel areas during both sampling periods. Zinc concentrations in sediments from both habitats were higher than the proposed criterion. During July sediments from four of the five main channel areas and both side channels sampled contained zinc concentrations that exceeded the criterion. During September zinc concentrations in sediments from two main channel areas and both side channels exceeded the maximum allowable value.

2.1.5 CLIMATE

The study area experiences a modified continental climate. Daily and seasonal changes in the weather are common because the area lies in the path of cold air moving south from Canada, warm and moist air coming north from the Gulf of Mexico, and dry air flowing from the west and southwest.

Winters are brisk though seldom severe while summers are hot. In St. Louis records since 1871 show that temperatures drop to zero or below on the average of two or three days per year, while the lowest temperature recorded at St. Louis was -22°F in January of 1844.

In the summer, temperatures rise to 90°F or higher on an average of 35 to 40 days per year. The months of June, July and August have normal daily maximum temperatures over 85°F and are generally the hottest months of the year.

Normal annual precipitation for the St. Louis area, based on the average for the period 1931-1960 is about 35 inches, a maximum of 68.83 inches was recorded in 1958 while a minimum of 20.59 inches occurred in 1953.

2.1.6 AIR QUALITY

The majority of the Upper Mississippi and Lower Illinois River basins is rural and consequently is relatively free of air pollutants. The southern end of Pool 26 receives air pollutants from the St. Louis Metro Area during periods of southerly wind flow.

2.2 BIOLOGICAL ELEMENTS

2.2.1 AQUATIC COMMUNITIES

2.2.1.1. General.

The summary description of the aquatic communities in Navigation Pools 24, 25, and 26 of the Mississippi River between Alton, Illinois, and Hannibal, Missouri (referred to as Upper Mississippi

River; approximate river miles 200-300), and the Illinois River between Grafton and Beardstown, Illinois (referred to as Lower Illinois River; river miles 0-80) is based on the preliminary results of on-going studies being conducted by the U.S. Army Engineer Waterways Experiment Station (WES), Vicksburg, Mississippi.

The U. S. Army Engineer District, St. Louis (SLD) requested WES to perform an environmental inventory and assessment of biotic and abiotic factors within the project area. The overall project objectives were as follows: (1) to provide a comprehensive data base for the project area; (2) to establish a reference source for preparation of an Environmental Statement for operation and maintenance of the 9-foot channel in the project area; (3) to provide documentation of changes, if any, occurring as a result of operation and maintenance activities; (4) to study alternative operation and maintenance techniques; and (5) to provide additional information to facilitate wise use of existing resources of the area.

An interdisciplinary study team composed of investigators from WES, SLD, Colorado State University (CSU), Southern Illinois University (SIU), Illinois Natural History Survey (INHS), and Missouri Botanical Garden (MBG) participated in different aspects of the study.

In addition to coordinating the various research efforts of other team members mentioned above, WES conducted a study that provided an ecological characterization of the aquatic ecosystem within the study area. This study represents the most recent and most extensive inventory of the aquatic communities. Samples were collected from 50 sites on the Upper Mississippi River and 21 sites on the Lower Illinois River from four different habitats during two periods, one following a continued period of high flow (July 1974) and another during a period of low flow (September 1974).

Although final analysis and interpretation of the data collected in this study have not been fully completed, for the purposes of this summary, a brief description of the biological characteristics of four major aquatic habitats studied is presented. Those major aquatic habitats include the main channel, river border area, diked area, and side channels.

2.2.1.2. Community Characteristics.

a. Habitats. The surface areas of the four major habitats in the study area were calculated using a computer and digitizer/plotter. Areas of the habitats were integrated using 1972 navigation charts for the Upper Mississippi River and 1970 navigation charts for the Lower Illinois River. The main channel habitat was defined as the navigation channel which has a minimum depth of 9 feet and a minimum width of 300 feet. Side channels included any departures from the main channel which were connected to the main river during mean flows. Dike habitat was arbitrarily defined as that area directly downstream from a dike or dike field for a distance of one-quarter mile. River border habitat was considered

to be that area in the main river exclusive of areas calculated for dike and main channel habitats.

The total combined area of all four habitat types calculated for Pools 24, 25, and 26 of the Upper Mississippi River was 56.67 square miles (Appendix C, Table 1). Of this total, river border areas accounted for 42.9 percent, side channels for 29.5 percent, dike areas for 19.1 percent and the main channel for only 8.4 percent.

Total area of the same habitats in the lower 80 miles of the Illinois River amounted to 15.10 square miles. Relative percentages of the four habitats were as follows: river border areas. 58.7 percent; main channel, 29.9 percent; side channels, 9.3 percent; and dike areas, 2.1 percent. River border areas, for both the Mississippi and Illinois Rivers, account for the majority of the total areas. In the Illinois River, side channels and dike areas are poorly represented on the basis of surface area. Conversely, these habitats together account for about 50 percent of the total area calculated for the Mississippi River.

b. Phytoplankton.

(1) Mississippi River. Phytoplankton samples were collected from main channel and side channel habitats during July and September 1974. The numbers of different genera collected from both side channel and main channel habitats were essentially the same, 130 and 129, respectively (Appendix C, Table 2). Genera collected from each habitat represented four phyla: Chlorophyta, Chrysophyta, Cyanophyta, and Euglenophyta. Among side channels, Chrysophyta made up about 80 percent of the total density (Appendix C, Table 3). Chlorophyta and Cyanophyta were the next most common forms. Euglenophyta accounted for about 3 percent of the total density.

Similar to the observations made among side channels, Chrysophyta accounted for about 72 percent of the total density in main channel habitats (Appendix C, Table 4). Chlorophyta, however, was more abundant in main channel habitats than in side channels, accounting for 30 percent of the density. Cyanophyta and Euglenophyta together accounted for less than 10 percent of the total.

(2) Illinois River. The number of different genera collected from side channels and main channels in the Illinois River was about half of the total number of genera which were collected from similar habitats in the Mississippi River (Appendix C, Table 2). Sixty-two different genera from side channels and 83 from main channel habitats were identified. While diversity was observed to be greater among main channel areas, a greater mean total density was calculated for side channels than for main channel areas (Appendix C, Tables 5 and 6). Consistent with observations made for the Mississippi River, of the four phyla represented in the samples, Chrysophyta was numerically dominant and

represented about 75 percent of the total density in both habitats. Chlorophyta was the next most dominant group represented in side channels (17.1 percent) and in main channel areas (19.6 percent).

c. Zooplankton.

(1) Mississippi River. Zooplankton were collected concurrently with phytoplankton from side channel and main channel stations. Twenty-seven genera were identified from side channels while 21 genera were identified from main channel areas (Appendix C, Table 7). All genera collected represented three major groups: Cladocera, Copepoda, and Rotifera.

Mean total density for zooplankton collected from side channels was 31.1/liter (Appendix C, Table 3). Of that total, Rotifera accounted for 66 percent, Copepoda for 29 percent, and Cladocera for about 5 percent. The same trend was observed among main channel areas: Rotifera made up 53 percent of the mean total density, Copepoda accounted for 39 percent, and Cladocera accounted for about 8 percent (Appendix C, Table 4). Zooplankton densities calculated for main channel areas were about half of those observed among side channels.

(2) Illinois River. A composite list of zooplankton identified from side channel and main channel stations in the Illinois River is presented in Appendix C, Table 7. The diversity among main channel areas was greater than the diversity among side channels. Among main channel areas, 20 genera were identified; 15 were identified from side channel areas.

In addition to a more diverse zooplankton fauna, higher densities of zooplankton were observed in main channel areas (Appendix C, Table 5). Of the mean total density (30.6/liter) of zooplankton associated with main channel areas, over 50 percent were represented by Copepoda. Rotifera accounted for 40 percent, and Cladocera accounted for five percent of the total density. Zooplankton were less abundant among side channels. The mean total density of zooplankton was 21.5/liter. As was observed for main channel areas, the dominant group was Copepoda, which accounted for about 50 percent. Rotifera, however, were more abundant in side channels than in main channels, accounting for almost 43 percent of the total density. Cladocera accounted for the remaining seven percent.

d. Benthos.

(1) Mississippi River. Benthic organisms were collected from the four major habitats. Of the four habitats studied, the greatest number of different genera (69) were collected among river border areas (Appendix C, Table 8). Fifty-nine genera were identified from side channels, 56 from dike areas, and 39 from the main channel.

Side channels of the Mississippi River supported the highest densities and diversity of benthic organisms of all habitats sampled (Appendix C, Table 3). Based on the mean total density ($951.3/m^2$) and mean species diversity calculated over sampling periods, aquatic Insecta and Oligochaeta accounted for 55 and 42 percent, respectively. Gastropoda, Crustacea, Hirundinea, Nematoda, and Pelecypoda were represented, although their abundance was small.

Dike areas supported the next highest densities and species diversity of benthic organisms (Appendix C, Table 9). Based on samples collected in July and September 1974, the mean total density was $694.7/m^2$ and mean species diversity was 1.82. As they had in the side channels, Insecta, representing 55 percent of the total, and Oligochaeta, representing 43 percent, numerically dominated all other groups in the dike area. Pelecypoda, Gastropoda, and Crustacea combined accounted for the remaining two percent.

River border areas sampled for benthos showed similar trends to those observed for side channels and dike areas. Major groups represented in the samples were Insecta and Oligochaeta (Appendix C, Table 10). However, these groups were not so evenly distributed as was observed for side channels and dike areas. Almost 87 percent of the mean total density ($539.3/m^2$) were represented by Insecta. Oligochaeta accounted for 10 percent of the total density. Mean species diversity was 1.58. No representatives of Crustacea or Gastropoda were identified from the samples analyzed.

The main channel area of the Mississippi River supported the lowest benthos densities of the habitats sampled. As stated earlier, the lowest diversity was also observed for this habitat. Mean total density was $154.8/m^2$ and mean species diversity was 1.31. Only four groups of organisms were represented in the samples (Appendix C, Table 4). Insecta accounted for 90 percent of the mean total density; Oligochaeta made up about nine percent. Pelecypoda and Gastropoda together accounted for less than one percent of the mean density.

(2) Illinois River. The same four habitats that were sampled for benthos in the pool areas of the Mississippi River were also sampled in the Illinois River during July and September 1974. Fifty-two genera were identified from river border areas, 31 from side channels, 22 from the main channel, and 18 from dike areas (Appendix C, Table 8). This trend was similar to the one observed for the Mississippi River, except that for the Illinois River, fewer genera were identified from dike areas rather than from the main channel.

The one dike area sampled for benthic organisms in the lower 80 miles of the Illinois River yielded the highest density of benthos of the habitats sampled. It should be pointed out that the results based on such a small sample size may not be representative. Dikes are not a characteristic feature of this reach of the Illinois River and make up only 2.1 percent of the total area. Almost 76 percent of the mean total density ($873.0/m^2$)

associated with this dike area was represented by Oligochaeta (Appendix C, Table 11. Mean species diversity was 2.57, second only to side channels. Only two other groups were collected in the samples; Insecta, which accounted for 19 percent, and Pelecypoda, which accounted for about five percent.

Side channel habitats sampled in the Illinois River were ranked second in terms of diversity and abundance of benthos genera identified and first with respect to species diversity. Mean total density was $747.7/m^2$ and mean species diversity was 2.87. Like river border areas, the same three groups or organisms represented in the samples followed the same order of abundance. Oligochaeta made up 62 percent of the total, Insecta 20 percent, and Pelecypoda about nine percent (Appendix C, Table 6).

Six major groups of benthic organisms were identified from samples collected from the river border areas (Appendix C, Table 12). The mean total density, based on the July and September samples, was $551.8/m^2$ and the mean species diversity was 2.32. Insecta accounted for 50 percent of the total, Oligochaeta made up about 36 percent, and Pelecypoda accounted for 14 percent. Other groups which occurred among river border areas but which were not found in either dike areas and side channels included Hirudinea, Crustacea, and Turbellaria.

The abundance and diversity of benthic organisms was lowest in the main channel habitat of both rivers. Mean total density among main channel areas of the Illinois River was $85.7/m^2$ and mean species diversity was 1.22,(Appendix C, Table 5). As was observed for dike areas and side channels, only Oligochaeta, Insecta, and Pelecypoda were represented in samples collected from the main channel. However, in contrast to what was observed in the two habitats mentioned above, Insecta was the numerically dominant group (65 percent). Oligochaeta accounted for 22 percent, while Pelecypoda contributed about 13 percent of the total density. A list of the type and distribution of mussels collected by Starrett (1971) in the lower Illinois is shown in Table 48 (Appendix C). Table 49 (Appendix C) lists those species recorded since 1870.

e. Commercial Importance of Mussels. The shellfish resource of the Upper Mississippi River and Lower Illinois River have been largely unexploited since the 1920's, when the market for pearlshell buttons disappeared. In the late 1960's, some southern companies dealing in mussel shell and shell products set up commercial operations on the Upper Mississippi River. This was caused mainly by the market demand for shells by the Japanese pearl-culture industry. Pearl culturlists have found that a calcareous nucleus inserted into the oyster is the best material to use for a pearl to form around. Mussels that have massive shells are the most desirable, such as *Amblema*, *Quadrula*, *Pleurobema*, and *Meyalonais* which are

found in the Mississippi and Illinois Rivers. Most of the mussel shells companies that operated on the two rivers were from Tennessee and Alabama where mussel populations were depleted to an extent that shells became scarce and prices rose.

A boat equipped with three 20-foot crowfoot brails and two men can take up to a ton of clams per day, but the average is probably closer to 800 pounds. The clams are cooked in large vats which separates the meat from the shell. Little or no effort is spent on searching the meat for pearls, although some independent clammers do this. At present the shell industry has declined from what it was in the late 1960's.

f. Drift. It has long been recognized that drift organisms may contribute significantly to river ecosystems. Measurements of quantities of drifting organisms in riverine systems have indicated that the drift component is important as food items for fish, as colonizers of previously disturbed substrates, and as indicators of water quality.

Drift has been shown to vary with seasons (temperature), time of day (light intensity), and life history and morphological adaptations of the species involved. It has also been hypothesized that the quantity of drift is related to production in the stream. This hypothesis suggests that the drift component during normal stream flow is composed of "excess" organisms produced on the substrate.

During July and September 1974, the Waterways Experiment Station sampled drift during 24-hour periods in a side channel and main river channel in the Mississippi (river mile 255.5) and Illinois Rivers (river mile 57.6).

The side channel station sampled in the Mississippi River was in Westport Chute, about three miles downstream from its head. The side channel station sampled in the Illinois River was about 1.4 miles downstream from its head at the upper end of Big Blue Island.

The sampling program was designed to establish the diel (24-hour) variation in the species composition, total numbers, and biomass of drift organisms passing through the sampling areas.

Five collections during a 24-hour period were made from both the main channel and the side channel in the Mississippi River, while six collections were made in the Illinois River during both sampling periods.

An attempt was made to sample both side channel and main channel stations at equal times of the day and night to insure comparability of data. From the data collected, comparisons of numbers and biomass as well as the quality or species composition of the drift were made. These data are presented in Appendix C, Tables 13 through 20.

(1) Mississippi River (Main Channel). During both sampling periods the quality and quantity of the drift varied with time of sampling. In July, the samples were characterized by a greater variety of organisms, including Odonata, amphipods, snails, hemipterans, beetles, and larval fishes which were not found in September (Appendix C, Tables 13 and 15). Mayflies dominated all other forms in terms of total numbers and biomass in the July samples However, in the September collections, caddisflies accounted for most of the total drift by numbers and biomass. This difference is probably related to the different life cycles of these two major groups.

While the diversity of total drift during the 24-hour period was greater in July, total numbers and biomass of drift organisms captured were about twice as high in September. Only in the main channel of the Mississippi River was this relationship observed.

(2) Mississippi River (Side Channel). Similar to the observation made in the main channel, there was a greater diversity organisms collected from side channels during July than in September (Appendix C, Tables 14 and 16). The total collections contained representatives of the same groups found in the main channel. Mayflies were most abundant during July, and caddisflies were collected in greatest numbers during September.

During July, total numbers and biomass were five times greater than those represented by the September samples. Cladocerans, most important (numerical and biomass) group found in July, were replaced by midges (numbers) and mayflies (biomass) in September. As observed in the main channel habitats, the major component of the drift occurred during the hours of darkness.

The primary difference between the two habitats, based on a gross comparison, is that during the July sampling period, the side channel yielded about three times the quantity (both numbers of organisms and biomass) as the main channel. During the September sampling period, the main channel yielded greater numbers and biomass than did the side channel. Differences of these types are difficult to explain, but they probably are related to differences in flow rates.

(3) Illinois River (Main Channel). The difference in the numbers of major groups represented in collections during the 24-hour sampling periods during both months was not as large in the Illinois River as the Mississippi River main channel (Appendix C, Tables 17 and 19). Three orders of larval fishes were the only major groups found in July that were not found during September. Total biomass and total numbers of organisms collected in July were four and ten times greater, respectively, than in September. Of the groups represented in collections during both periods, the most dramatic change was associated with the Cladocera. The density of Leptodora kindtii, a large cladoceran, approached

27,000/100 m^3 during July. During September, its density was recorded as 1/100 m^3.

(4) Illinois River (Side Channel). Drift samples collected from the side channel station during July represented a more diverse assemblage of organisms and contained greater numbers and biomass than did those samples collected for September (Appendix C, Tables 18 and 20). The most abundant group in July was the cladocerans. However, mayflies, caddisflies, and larval fishes were comparable in terms of biomass. The number of cladocerans was reduced from a total of 6,000 per 24-hour period in July to 14 per 24-hour period in September. Accompanying this reduction in abundance of the cladocerans was a general decrease in the total biomass and total numbers. The only group to increase in abundance during September was the caddisflies.

The main channel habitat was characterized by considerably higher total numbers of drift organisms per 24-hour period in July as compared to the side channel. Total biomass estimated from each habitat was similar. Side channel and main channel habitats were more similar during September than during July.

(5) Conclusions. Drift organisms are significant in both the Mississippi and Illinois Rivers. A greater percentage of the total drift occurs during the hours of darkness. The drift was greater during high flow than during average flow. This difference could be related to the life histories of the organisms as well as to physical influences, such as the flow of water. No oligochaetes and few mollusks were observed in drift samples.

g. Fish. The inventory of the aquatic communities conducted by the Waterways Experiment Station for the Upper Mississippi River did not include fish collections. Instead, a literature survey was conducted to obtain available references which would provide pertinent fishery data for the study area. Concurrently, Dr. Richard Sparks, Illinois Natural History Survey, conducted an electrofishing survey of the lower 80 miles of the Illinois River (Sparks, 1974). The primary objective of Sparks' study was to provide an estimate of the relative abundance and to determine species composition of fish populations in the Lower Illinois River. The Illinois Natural History Survey has been actively engaged in electrofishing surveys of the Illinois River for many years. Data collected in 1974 have been evaluated with reference to historical data dating back to 1959.

Pertinent documents published prior to the construction of the series of locks and dams deal primarily with the entire Illinois and Mississippi Rivers or with specific sections within the rivers. Much of the recent literature has included information about specific navigation pools. For this environmental statement the discussion is directed toward a consideration of (1) the entire upper reaches of both rivers (from St. Louis, Missouri,

to Minneapolis, Minnesota, on the Mississippi River; and from Grafton, Illinois, to Chicago, Illinois, on the Illinois River) and (2) navigation Pools 24, 25, and 26 on the Mississippi River; and the lower 80 miles of the Illinois River. The commercial fishing statistics were taken from the Annual Proceedings of the Upper Mississippi River Conservation Committee (UMRCC) (1948-1974).

(1) Species Composition. The Keokuk Dam, located on the Mississippi River at river mile 364.3, was contructed by a private power company in 1913. Prior to the construction of this dam, there were no permanent barriers across the Mississippi River.

Following completion of Keokuk Dam, the U.S. Bureau of Fisheries and Wildlife (now U.S. Fish and Wildlife Service) intitiated a study to determine what effect the dam had on the upstream migration of fish. Results of the study indicated that the dam formed a barrier to extensive upstream migration of the following fishes: American eel (*Anguilla rostrata*), buffalo (*Icitobus* sp.), carp (*Cyprinus carpio*), catfish (*Ictalurus* sp.), freshwater drum (*Aplodinotus grunniens*), Alabama shad (*Alosa alabamae*), paddlefish (*Polyodon spathula*), sauger (*Stizostedion canadense*), shortnose gar (*Lepisosteus platostomus*), shovelnose sturgeon (*Scaphirhynchus platorynchus*), and skipjack herring (*Alosa chrysochloris*). In all probability, spawning of at least three species, the blue sucker (*Cycleptus elongatus*), Alabama shad, and skipjack herring, has been impaired (Carlander, 1954). No reference was made by Carlander regarding who other species were not affected.

The species composition has changed significantly since the 1880's. Appendix C, Table 21 is a current list of the most common species associated with navigation Pools 24, 25, and 26 of the Mississippi, and the lower 80 miles of the Illinois River. From a comparison of recent studies with those conducted before 1908, it appears that 18 species of fish have disappeared from the Illinois River (Mills, 1966). Carlander (1954) noted that several species of fish have completely or almost completely disappeared from the Upper Mississippi River commercial catch since the 1890's. These fish species include the following: walleye (*Stizostedion vitreum*), sauger, yellow perch (*Perca flavescens*), white bass (*Morone chrysops*), yellow bass (*Morone mississippiensis*), sturgeon, paddlefish, and American eel. Increased turbidity, sedimentation, chronic pollution, reduced habitat and food organisms, construction of dams and impoundments, and drainage of bottomlands are thought to be important factors contributing to the disappearance of certain commercial fish species (Mills, 1966; Smith, 1971). Also, fishing regulations have changed, eliminating some species from the commercial catch.

(2) Sport Fishery. A number of major habitat types potentially provide the sport fisherman opportunity for catching fish. These include: main channel, river border area, dike areas, side channels, bottomland lakes, and backwater areas.

Tailwater habitats below dam structures, backwater areas, and bottomland lakes adjoining the river are actively used by sport fishermen (Barnickol, et al., 1951). Barnickol, et al., (1951) indicated that numbers of sportfish are greater in the upper end of navigation pools and in side channel areas than in other habitats. Bertrand, et al., (1973) found greater numbers of sportfish in the side channel areas than in the other habitats.

The WES study indicated that side channel and river border areas characteristically have a more diverse species composition than main channel areas. For example, Ragland (1974) observed that fish species more commonly associated with the side channels included: bigmouth buffalo (*Ictiobus cyprinellus*), black crappie (*Pomoxis nigromaculatus*), bluegill (*Lepomis macrochirus*), bowfin (*Amia calva*), carp, gizzard shad (*Dorosoma cepedianum*), largemouth bass (*Micropterus salmoides*), shortnose gar, and white bass. Ragland (1974) noted that species such as freshwater drum and sauger appeared to prefer the river border areas. However, Ragland's study was not conducted in the project area and therefore the results from that study as they apply to the project area have not been verified.

The sport fishery in the Illinois River has generally declined from pre-1900 levels. This decline is attributable to a loss of habitat and increased pollution. Habitat was lost in some areas through leveeing and draining of bottomland areas in the 1920's and by siltation in other areas. Siltation has resulted in undesirable habitat modification as well as habitat reduction (Sparks, 1974).

(3) Commercial Fisheries. The commercial fishery of the Mississippi River is essentially based on four groups of fish: carp, buffalo, catfish, and freshwater drum (Sullivan, 1971). Commercial fishing records in the Upper Mississippi River date back to 1869 (Carlander, 1954). The most pronounced change in the fishery has been the change in abundance of various fish species. According to Carlander (1954), the commercial harvest of carp, a species which was not present in the river before 1800, increased significantly during the early twentieth century. For the present study, analysis of commercial fishing statistics for Pools 24, 25, and 26 indicate that carp represented approximately 38.5 percent of the total commercial catch based on data from 1953-1973 (Appendix C, Table 22). In 1894, buffalo comprised about 43 percent of the total poundage. The ratio of buffalo to carp at this time was 12:1. By 1899, the ratio of carp to buffalo was about 1:1 (Carlander, 1954). A 3:1 ratio for carp to buffalo essentially was constant from 1922 to 1954 (Carlander, 1954). Based on UMRCC statistics, the ratio of carp to buffalo within the study areas has been approximately 1.5:1 from 1953 to 1973 (Appendix C, Table 22).

All major commercial species have exhibited fluctuating harvest trends throughout the 20-year period 1953-1973, which is characteristic of most fish populations (Appendix C, Figures 1

through 4). Carp have varied from approximately 222,000 pounds (in 1953) to approximately 652,000 pounds (in 1965), yielding an average yearly catch of 377,000 pounds. Buffalo have varied from approximately 155,000 pounds (in 1953) to approximately 370,000 pounds (in 1955), yielding an average yearly catch of 239,500 pounds. Data for catfish indicate a range from approximately 84,000 pounds (in 1973) to 305,000 pounds (in 1964), yielding an average yearly catch of 181,100 pounds. The harvest of freshwater drum varied from 77,000 pounds (in 1968) to 197,000 pounds (in 1955), averaging 148,000 pounds annually. There appears to be no direct correlation among the four species regarding the fluctuating trends.

2.2.2 TERRESTRIAL COMMUNITIES

2.2.2.1 Vegetational Communities

A total of 324 terrestrial plant species in 80 families were observed during 1974 in the project area by Klein, et al., (1975). Voucher specimens were deposited in the herbarium of the Missouri Botanical Garden and the list is reproduced here in Appendix C, Table 23.

Plant communities are usually described on the basis of their species composition and the relative contributions of these species to the community. Many quantitative measures such as cover, frequency, density and basal area can be used to determine the importance of a species to a particular community. Cover was selected as the important parameter in this study area because it was appropriate to the objectives of the study and because it was an easily applied, reliable measure (Klein, et al., 1975).

Cover class data were obtained from forest stands within the project area and quantitative data were gathered from old field and wetland islands. The locations of stands are indicated in Figure 2-17. Old field and wetlands communities and forest communities were recognized by Klein, et al., (1975). Plant communities and their distribution are indicated in Plate 4, A-D.

2.2.2.2 Vegetation Types

a. Nonforest--old fields. Cultivated lands which have been abandoned develop old field communities. These were not numerous in the study area but are important because they are a starting point for secondary succession and because they are an important wildlife habitat.

Seven old field communities on the floodplain, including one on a Pleistocene terrace, were examined. All but one of these contained tree species, which were usually less than two meters tall. Herbs were common in all stands, usually with cover of at least 75 percent. The forbs and graminoids usually reached into the 0.5 to 2 meter class and were common at all levels to the ground.

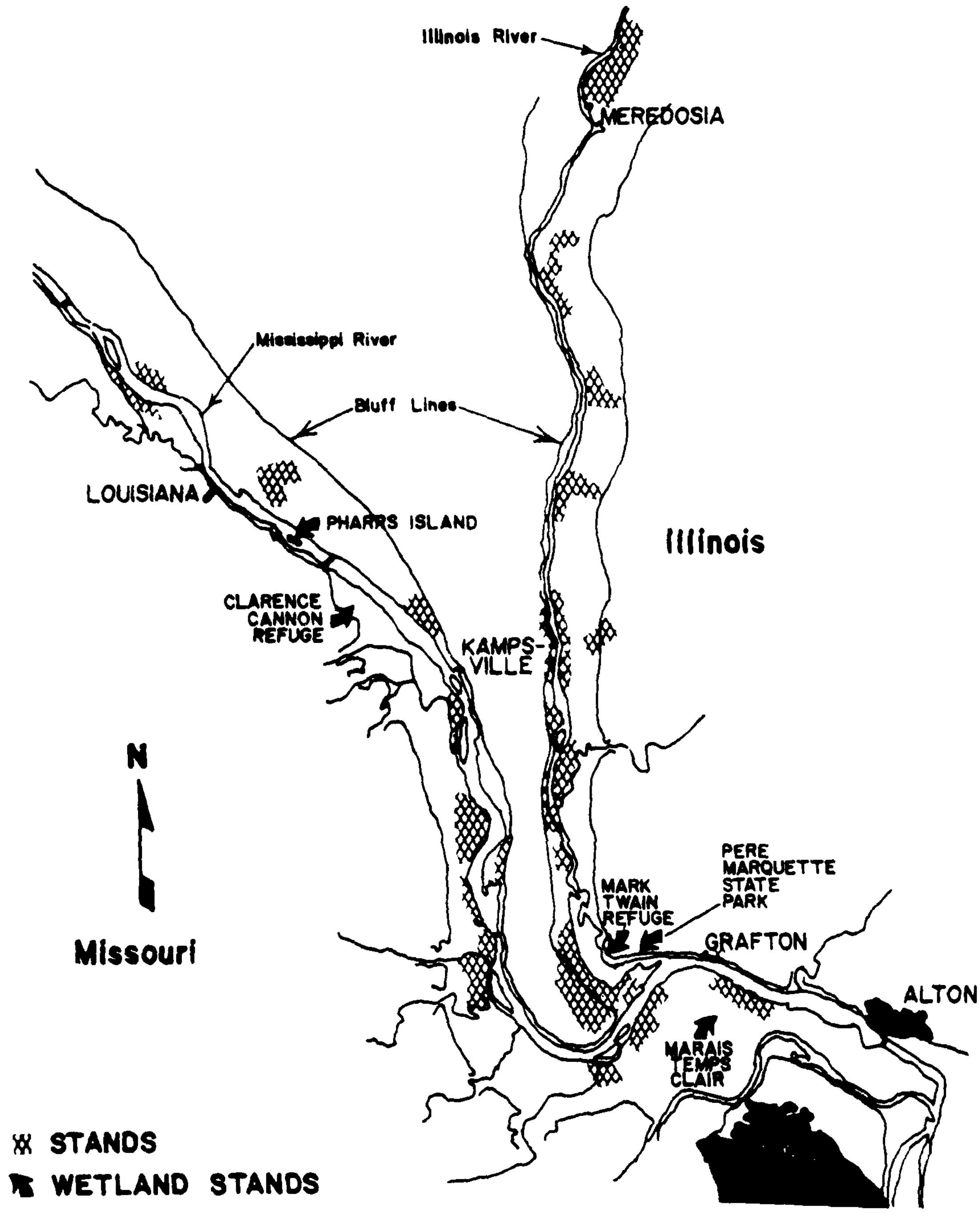


Figure 2-17 Area map of stands examined and wetland stands sampled

Seventy-eight species, plus eight additional taxa identified to genus only, were collected from these seven sites. Only eight species occurred at three or more sites. The most important species were cocklebur (Xanthium spp.) and yellow nut grass (Cyperus esculentus), each of which had a cover of over 75 percent in one stand. Next in importance was smartweed (Polygonum spp.). Five species were found in old fields: P. erectum, P. lapathifolium, P. pensylvanicum, P. persicaria, and P. punctatum. The cover of smartweed was usually low, often less than five percent.

Timothy (Phleum pratense) was common at two sites, including the one on a terrace, and was found less abundantly at one other site. Swamp milkweed (Asclepias incarnata) was found at three sites in low to moderate numbers. Morning glory (Ipomoea spp.) was found at as many as three. Water parsnip (Sium suave) was the only other species that was found at as many as three sites, always with a low cover value.

Cottonwood (Populus deltoides) was the most common tree species found, followed by willow (Salix spp.), white ash (Fraxinus americana), and silver maple (Acer saccharinum). The only field with pin oak (Quercus palustris) was the terrace site and the forests on these sites were also anomalous (see discussion of Oak-Hickory Community).

Many old fields, especially along the Illinois River, were flooded most of the summer (1974). Four of these were examined for successional patterns. The primary invader was cocklebur (Xanthium pensylvanicum) with a cover greater than 75 percent. Smartweed (Polygonum pensylvanicum) and morning glory (Ipomoea lacunosa) were less abundant. Older fields with trees present had a similar species composition, but the cover of cocklebur was not as high. Other common species were fog fruit (Lippia lanceolata), yellow nut grass, and water hemp (Amaranthus tamariscinus). Trees most commonly found were cottonwood and silver maple, usually occurring as very dense stands of trees one to two meters tall. Willow and buttonbush (Cephalanthus occidentalis) were found in fields located close to the river.

b. Nonforest--wetland communities. Wetland may be divided into three major groups based upon their physiognomy: forb dominated, graminoid dominated, and those dominated by broadleaf deciduous trees.

Four forb-dominated wetlands were quantitatively sampled. One, located near Pere Marquette State Park, exemplified the physiognomic changes that took place along a moisture gradient. The first section of this wetland was dominated by American lotus (Nelumbo lutea). It had approximately one meter of standing water in it on the day examined (27 September, 1974). Lotus covered an estimated 75 percent of the area and was the only common species. Big duckweed (Spirodela polyrhiza) and pondweed (Potomogeton pectinatus) were the only other species observed

in this stand. Their combined cover was less than five percent. In shallow water (less than 10 centimeters), mud plaintain (Heteranthera limosa) was found. Adjacent to this area, an arrowhead community (Sagittaria latifolia and S. graminea) was sampled with 10 random quadrats. Total cover was estimated as 57 percent. The second most important species, by cover, was again big duckweed with only about six percent cover. No other species covered as much as five percent of the stand.

Closer to shore, grasses, sedges, and smartweed replaced the arrowhead. Ricecut grass (Leersia oryzoides) and yellow nut grass (Cyperus esculentus) were the dominant species. Primrose (Jussiaea repens) was also common.

The successional pattern indicated that eventually the lotus community will be replaced by the arrowhead community which in turn will be supplanted by the graminoid community.

A similar pattern was found in a wetland on Pharrs Island. To demonstrate the species gradient, atransect was run from the edge of a forest through a marsh until the vegetation ceased to change in open water (a distance of about 35 meters). The first 23 meters of the transect were quite muddy. Tall white aster (Aster simplex) was the dominant herb. The most notable vegetation change through the transect was the gradually increasing abundance of arrowhead from the shore to the end of the transect. In the first 10 meters of the transect, arrowhead had a mean cover of only one percent (70% frequent, i.e., occurred in 70 percent of the quadrats). In the following 10 meters, its cover increased slightly to five percent (90%). In the third 10 meter segment, its cover averaged seven percent (10% frequent). In the final five meters, the cover of arrowhead averaged 43 percent (100% frequent).

The last 11 meters of the transect had 15 centimeters of standing water. Lesser duckweed (Lemna minor) was a codominant in these quadrats. Its mean cover was 43 percent. It should be noted that duckweed is a floating vascular plant and thus subject to movement by wind. Its abundance increased markedly in the last few meters of the transect. Smartweed (Polygonum pensylvanicum) was rare in the quadrats, though a large patch was found just to the side of the transect. Tree seedlings of three species (willow, Salix nigra; silver maple, Acer saccharinum; and cottonwood, Populus deltoides) were present, though rare, in the transects, suggesting tree invasion. There were no seedlings found in the last 15 meters (the wettest) of the transect. In fact, only three species were found in these last 15 meters, arrowhead, duckweed, and smartweed (Polygonum punctatum). The latter occurred in only one of these quadrats with a cover of five percent.

At the end of the transect lay an open water community dominated by American lotus. There was approximately 1.3 meters of standing water in this community at the time of study. The total estimated cover was 40 percent.

A drier wetland, sampled on the Clarence Cannon Wildlife Refuge, was dominated by forbs and grasses. This area (in "old goose pasture"), according to the refuge manager, is manipulated by pumping of water to promote the growth of smartweed (Polygonum coccineum) and wild millet (Echinochloa crus-galli). These were the most important species, with smartweed providing 13 percent of the cover (55% frequent) and wild millet providing an estimated 10 percent cover (95% frequent). This vegetation probably represents a successional stage following the arrowhead community.

Another wetland area, located at Marais Temps Clair, was sampled. It was dominated by rice cut grass (Leersia oryzoides). Rice cut grass had a mean cover value of 83 percent (100% frequent) providing most of the total stand cover (91%). Wild millet (Echinochloa crus-galli) was the second most common species with a mean cover of only five percent, whereas smartweed (Polygonum persicaria) had a cover of four percent (70% frequent).

The final wetland area sampled was located in the Mark Twain National Wildlife Refuge. This wetland had a dense herbaceous stratum but also had a number of young trees. It was being invaded by two woody species, buttonbush (Cephalanthus occidentalis), and black willow (Salix nigra). The most important herb was yellow nut grass (Cyperus esculentus) with a mean cover of 14 percent (75% frequent). The second-ranked herb (by cover) was smartweed (Polygonum coccineum) with an estimated cover of 15 percent, but a relatively low frequency value of 35 percent. Cocklebur (Xanthium pensylvanicum) had a cover value of 11 percent, but was nearly twice as common as smartweed with a frequency of 65 percent. Dodder (Cuscuta sp.), a vascular plant which parasitizes other plants, was common (70% frequent), but its importance is probably minimal since its cover was estimated as only two percent. Rice cut grass (Leersia oryzoides) was another important species with a mean cover of seven percent and a frequency of 48 percent. Tall white aster (Aster simplex) was the only other important species with a mean cover of 15 percent and a frequency of 55 percent.

c. Forest--willow community. Willow communities occur most often as narrow bands along river banks and sloughs on the Mississippi and especially on the Illinois River. They are also found on the developing ends of growing islands, which have very sandy soil and are subject to frequent, prolonged periods of flooding. The importance of the willow community is its pioneering ability. As willows invade new land, they slow flood waters, causing them to deposit their sediment load, thus building land.

The willow community was comprised principally of three species: black willow (Salix nigra), sandbar willow (S. interior), and S. rigida. Sandbar willow, a small tree which usually does not grow over seven meters tall, is a primary colonizer of sand flats, particularly along the Illinois River. It is immediately followed by black willow and Salix rigida, giving a banded appearance to the forests along river banks and on islands.

Young willow stands are often very dense, and, for the first eight to ten years, the stand is comprised exclusively of willows. Most stands are even-sized. At five years they are 2.5 to 3 meters tall with a dbh (diameter breast height) of about 10 centimeters. Willows are very shade intolerant and as the stand matures they are replaced by cottonwood and silver maple.

Mature willow stands are comprised of trees usually ranging from 10 to 20 meters in height and the typical range of dbh is from five to 20 centimeters. Vegetative cover gradually decreases toward the ground level, where it is usually only a few percent.

In the 10 stands of willow community which were examined, a total of 22 woody species were collected. Thirteen of these, including a group of planted bald cypress (Taxodium distichum), occurred in only one or two stands. Swamp privet (Forestiera acuminata) and buttonbush (Cephalanthus occidentalis) were the next most common trees, each occurring in approximately one-half of the sites. Their cover values were always less than 25 percent and usually less than five. Box elder (Acer negundo) and ash (Fraxinus spp.) were each occasional species with less than five percent cover.

Climbers were uncommon and rarely had a cover of over one percent. Wild grape (Vitis spp.) and trumpet creeper (Campsis radicans) were the most common vines. Similarly, the herbaceous cover was usually less than five percent. Smartweed (Polygonum spp.) and arrowhead (Sagittaria latifolia) were the only common herbs, and they were collected in approximately one-half of the stands. Fog fruit (Lippia lanceolata) and yellow nut grass (Cyperus esculentus) were not found in many stands but were common in some. No other herbs were common, though a total of 33 species was collected.

d. Forest--silver maple-cottonwood community. The most extensive forest community along the Mississippi and Illinois Rivers is the silver maple-cottonwood (Acer saccharinum - Populus deltoides), which usually occurs interior to the willow bands. It sometimes borders rivers and sloughs. It is best developed

on the unprotected floodplain where it flourishes on soils varying from sandy to silty and can withstand limited annual flooding, though it is less flood tolerant than the willow community.

The silver maple-cottonwood canopy is often over 20 meters tall but is not closed at this height. The cover above 20 meters is usually about 25 percent, though it can be as high as 75 percent. Under this canopy is a lower stratum mostly of silver maple, 10 to 20 meters tall, with a coverage often exceeding 75 percent. Below this, the vegetative cover diminishes rapidly toward the ground.

This community is dominated by silver maple, whose cover often exceeds 75 percent, with cottonwood usually contributing another 25 percent. The most common species (i.e., occurring in at least 60 percent of the sites examined) associated with cottonwood and silver maple were American elm (Ulmus americana), willow (Salix spp.), swamp privet (Forestiera acuminata), red mulberry (Morus rubra), pecan (Carya illinoensis), box elder (Acer negundo), and ash (Fraxinus spp.). The cover of one of these species was rarely greater than 25 percent. Pin oak (Quercus palustris) occurred in about 25 percent of the sites, nearly always with a cover of less than five percent. In certain cases, pin oak was co-dominant with silver maple, but these sites are discussed separately (see Silver Maple-Cottonwood-Pin Oak Community).

Vines were nearly always present, but their cover was low. Wild grape (Vitis spp.), poison ivy (Rhus radicans), trumpet creeper (Campsis radicans), and catbriar (Smilax spp.) all occurred in most stands. Virginia creeper (Parthenocissus quinquefolia) was found in only about 15 percent of the sites. It appeared to be more important in the drier sites of the floodplains.

The ground cover was relatively sparse, covering less than 25 percent of the area in most cases and often less than five percent. The most common herbs were lizard's tail (Saururus cernuus), tall white aster (Aster simplex), stinging nettle (Laportea canadensis), smartweed (Polygonum spp.), and arrowhead (Sagittaria latifolia).

e. Forest--silver maple-cottonwood-pin oak community. Eight sites were classified as transitional between the silver maple-cottonwood and pin oak communities. These forests were located primarily along the Mississippi River in areas bordering the two communities. Dominance was shared by silver maple and pin oak, with cottonwood a less important member of the community.

The physiognomy of this community was similar to the silver maple-cottonwood. Some trees exceeded 20 meters in height, but their cover was low. Below this, the 10- to 20-meter class formed a continuous canopy cover. Between five and 10 meters, the cover was usually less than 25 percent. Forbs and graminoids were not abundant, while vines varied from uncommon to abundant.

The species composition of this community was generally more similar to the pin oak forest than to the silver maple-cottonwood. These forests generally had many common tree species and few rare ones. Silver maple and pin oak were the dominants, frequently with a cover of approximately 25 percent for each species. Cottonwood was much less common and was found in only 60 percent of the sites, with cover ranging from less than one to 25 percent. Ash (Fraxinus spp.), sugarberry (Celtis laevigata), box elder (Acer negundo), deciduous holly (Ilex decidua), willow (Salix spp.), American sycamore (Platanus occidentalis), red mulberry (Morus rubra), and roughleaf dogwood (Cornus drummondi) were all common.

The vines, observed in most other forests in the study area, included poison ivy (Rhus radicans), wild grape (Vitis spp.), trumpet creeper (Campsis radicans), and catbriar (Smilax spp.). Virginia creeper (Parthenocissus quinquefolia) was found in approximately 40 percent of the stands, always with a low cover value. As with the other communities, there were few common herbs. Only two, lizard's tail (Saururus cernuus) and smartweed (Polygonum spp.), were found in as many as 25 percent of the sites examined. Tall white aster (Aster simplex), which was the second-ranked herb in the silver maple-cottonwood community, was found at only one site and had a very low cover value. The most common herbs in the pin oak community except for smartweed, were absent in this community.

f. Forest--pin oak community. Pin oak forests were most common on the protected floodplain of the Mississippi River, though they were occasionally found in unprotected areas as well. They were found to be more common in the southern part of the study area, Pool 26, than farther north.

The physiognomy of the pin oak community was similar to the silver maple-cottonwood type described earlier. The tallest trees reached over 20 meters in height and formed an open canopy with about 25 percent cover. A lower stratum in the 10- to 20-meter class was also open, usually with less than 50 percent cover. This contrasts with the silver maple-cottonwood community where a continuous cover was present at this height. Below 10 meters, the cover gradually decreased toward ground level. Small tree seedlings were usually found (less than 10 centimeters)

in pin oak forests, which contrasts with their absence in the silver maple-cottonwood forests. This indicates a relative absence of ground disturbance, particularly flooding.

There were more tree species in the pin oak community than in the silver maple-cottonwood.

Of the tree species in the pin oak community, 17 of 37 were found in at least one-half of the sites. This indicates a much more shared dominance in the pin oak forest. The more mesic conditions of the pin oak habitat probably contributed to greater diversity.

The most important species besides pin oak were silver maple (*Acer saccharinum*), pecan (*Carya illinoensis*), deciduous holly (*Ilex decidua*), sugarberry (*Celtis leavigata*), ash (*Fraxinus* spp.), American elm (*Ulmus americana*), and red mulberry (*Morus rubra*). Not only were these species present in most of the forests, but they each often had cover values ranging up to 25 percent. Many other species were often present but rarely provided as much as five percent cover. These included hackberry (*Celtis occidentalis*), hawthorn (*Crataegus* spp.), honey locust (*Gleditsia triacanthos*), bur oak (*Quercus macrocarpa*), persimmon (*Diospyros virginiana*), and roughleaf dogwood (*Cornus drummondi*). Neither cottonwood (*Populus deltoides*) nor willow (*Salix* spp.) was very common. Cottonwood occurred in approximately one-half of the sites and willow in about one-quarter. Their cover values were usually less than five percent.

Vines were much more common in the pin oak forest than in the silver maple-cottonwood community. Their cover values were as high as 25 to 50 percent. Poison ivy (*Rhus radicans*), trumpet creeper (*Campsis radicans*), wild grape (*Vitis* spp.), catbriar (*Smilax* spp.), and Virginia creeper (*Parthenocissus quinquefolia*) were all common. Herbaceous plants were more abundant than in the silver maple-cottonwood forest, but they rarely covered more than 25 percent of the ground. Few species were found in more than 10 percent of the sites examined. Giant ragweed (*Ambrosia trifida*), smartweed (*Polygonum* spp.), yellow wood-sorrel (*Oxalis stricta*), lizard's tail (*Saururus cernuus*), violet (*Viola* spp.), and tall bellflower (*Campunula americana*) were the most commonly encountered species.

g. Forest--oak-hickory community. Pleistocene river terraces were found above the confluence of the Illinois and the Mississippi Rivers and surrounding Calhoun Point. Most of this land was cultivated, but a few small forested areas remain. The physiognomy of this community was similar to that of the pin oak and will therefore not be repeated here. Although these forests are designated as oak-hickory communities, the species composition is not the same as in those found in typical upland

oak-hickory forests of the Midwest. In fact, no similar forests have previously been described.

Five stands were studied and the results suggest relative uniformity in the species composition. Six species of oak (Quercus spp.) and two species of hickory (Carya spp.) were found. Shagbark hickory (C. ovata) was the only one of these eight found in all five stands and had cover values ranging from five to about 50 percent. In one stand, shellbark hickory (C. laciniosa) had a cover of five to 25 percent. The oaks, in order of importance, were shingle oak (Q. imbricaria), swamp white oak (Q. bicolor), pin oak (Q. palustris), post oak (Q. stellata), northern red oak (Q. rubra), and chinquapin oak (Q. prinoides = Q. muhlenbergii). The combined cover of the oaks varied from less than one to 50 percent. Usually the individual oak species had cover values of only about five percent, except swamp white oak, which was found in three of the five stands and had cover values in the 25 to 50 percent class in each case.

Few other tree species were associated with the oaks and hickories. Slippery elm (Ulmus rubra) was present in four of the five sites but with less than five percent cover. Hawthorn (Crataegus spp.), deciduous holly (Ilex decidua), and black walnut (Juglans nigra) each occurred in three stands but, again, always with low cover values.

A sixth site, partly on the terraces and partly below them, was also examined. Its composition was consistent with the above, but it included pawpaw (Asimina triloba) and American basswood (Tilia americana), not found anywhere else in this study. The following trees were found only on the terraces: northern red oak, shingle oak, wild black cherry (Prunus serotina), black walnut, chinquapin oak, and post oak.

There were markedly fewer vines in the oak-hickory community than in the pin oak community. Only Virginia creeper (Parthenocissus quinquefolia) was found in all stands. Poison ivy (Rhus radicans) was collected in four of the five and wild grape (Vitis spp.) was found in two. No other vines were noted. Only two herbs were found in as many as three of the stands: touch-me-not (Impatiens spp.) and may apple (Podophyllum peltatum). The latter was found exclusively in these terrace stands. Herb cover was sparse in all cases.

The marked difference of this forest from any others examined is undoubtedly due to the habitat of the terraces. These areas are on the historical floodplain, they are not currently subject to flooding, they are not typical upland sites. The soils are very sandy and well drained.

In all, 116 forest stands were studied by Klein, et al., (1975), in the project area. They performed an ordination study from which they were able to conclude the existence of four types of communities: willow, silver maple-cottonwood, pin oak, and oak-hickory (Klein, et al., 1975, p. 60). In a summary of some of the cover data, Table 2-15 indicates the most important woody species in the 116 stands. Silver maple was clearly the most important, with cottonwood, willow, poison ivy, American elm, and ash being of secondary importance. Table 2-16 gives additional information regarding leading dominants. These data indicate that, based on dominance and co-dominance, silver maple, cottonwood, pin oak, willow, ash, American elm, and pecan were the leading species. Of these, only silver maple was dominant in 50% of the stands or more.

2.2.2.3 Successional Trends in Terrestrial Communities

Succession in any given area proceeds through a series of intergrading or overlapping stages, some discrete enough to be recognized. Early colonizing species are referred to as pioneers and are invaded and superceded as conditions gradually change. A site will eventually produce a stable community which is dynamic but unchanging in composition. This eventual and stable community is referred to as a climax community. It is interesting that whether succession proceeds on a xeric (dry) or a hydric (wet) site the successional trends are usually toward a common type of community and toward more mesic conditions. The presumed successional trends in the project area have been outlined by Klein, et al.,(1975), and are included herein as Figure 2-18. The conclusions are drawn from 116 sampled sites located variously within the project area. Klein, et al., (1975), suggest that succession proceeded either from abandonment of fields following agriculture or other utilization or from newly deposited island materials. They suggested one path of succession on terraces as beginning with old fields and terminating with a unique oak-hickory forest. A second begins with abandoned fields on low floodplains and terminates in a community dominated by pin oak with an admixture of other hardwood species. A third successional sequence begins with newly deposited island materials and proceeds to develop a similar climax community as the previous--dominated by pin oak with an admixture of other hardwood species. It is not known, however, whether three separate climaxes exist in the area: oak-hickory, pin oak, and maple-oak-elm, or whether the last-mentioned supercedes the pin oak type with time.

Succession can be viewed from the center to the edge of a feature such as a pond or river or from the margin to the center of a feature such as an island. Succession of the latter kind was viewed by Klein, et al., (1975), in their description of the vegetation of Degenhardt Island. Herbaceous annuals and perennials are located at the margins of the island, with woody vegetation occupying the center. The herb species are included

Table 2-15

Most Important Taxa of Woody Species[1]

Species	Mean Cover of Occurrence (in percent)
Silver maple (*Acer saccharinum*)	44.3
Cottonwood (*Populus deltoides*)	17.0
Willow (*Salix* spp.)	15.8
Poison ivy (*Rhus radicans*)	13.5
American elm (*Ulmus americana*)	11.0
Ash (*Fraxinus* spp.)	10.5
Pecan (*Carya illinoensis*)	9.5
Sugarberry (*Celtis laevigata*)	7.3
Box elder (*Acer negundo*)	6.9
Wild grape (*Vitis* spp.)	4.5
Trumpet creeper (*Campsis radicans*)	4.1
Red mulberry (*Morus rubra*)	3.4
White mulberry (*Morus alba*)	3.2
Catbriar (*Smilax* spp.)	0.6

[1]Occurrence in at least 50 percent of stands and mean cover of occurrence at least 10 percent, ordered by cover, most to least

Table 2-16

Leading Dominance

Species	Number of Stands as Leading or Coequal Dominant	Number of Stands as Second Dominant
Silver maple (*Acer saccharinum*)	60	69
Pin oak (*Quercus palustris*)	31	36
Willow (*Salix* spp.)	12	27
Pecan (*Carya illinoensis*)	11	17
Cottonwood (*Populus deltoides*)	7	40
Hackberry (*Celtis occidentalis*)	7	9
American elm (*Ulmus americana*)	6	22
Shellbark hickory (*Carya laciniosa*)	6	9
Ash (*Fraxinus* spp.)	5	25
Sugarberry (*Celtis laevigata*)	5	4
Deciduous holly (*Ilex decidua*)	5	1
Box elder (*Acer negundo*)	4	7
Slippery elm (*Ulmus rubra*)	4	1
Buttonbush (*Cephalanthus occidentalis*)	4	2
Bur oak (*Quercus macrocarpa*)	4	2
Swamp white oak (*Quercus bicolor*)	4	1
Roughleaf dogwood (*Cornus drummondii*)	3	0
Sycamore (*Platanus occidentalis*)	2	3
Shagbark hickory (*Carya ovata*)	2	2
Northern red oak (*Quercus rubra*)	2	0
Persimmon (*Diospyros virginiana*)	1	3
River birch (*Betula nigra*)	1	2
Honey locust (*Gleditsia triacanthos*)	1	1
Red mulberry (*Morus rubra*)	1	1
Sassafras (*Sassafras albidum*)	1	1
Flowering dogwood (*Cornus florida*)	1	0
Hawthorne (*Crataegus* spp.)	1	0
Wild crab (*Pyrus ioensis*)	1	0
Shingle oak (*Quercus imbricaria*)	1	0
Chinquapin oak (*Quercus prinoides*)	1	0
Post oak (*Quercus stellata*)	1	0
Bramble (*Rubus* spp.)	1	0
Swamp privet (*Forestiera accuminata*)	0	6
White mulberry (*Morus alba*)	0	2
Redbud (*Cercis canadensis*)	0	1
Bald cypress (*Taxodium distichum*)	0	1

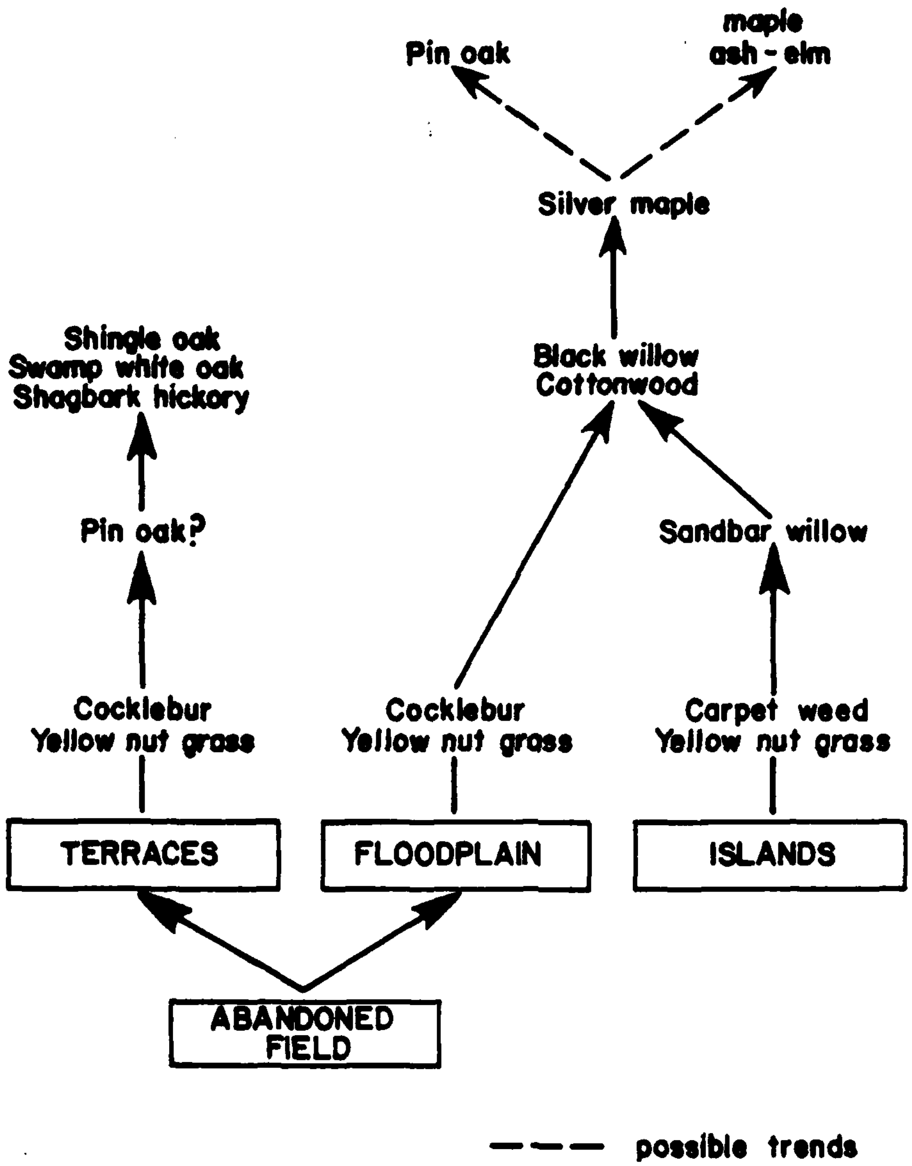


Figure 2-18Probable successional sequence of communities

herein with notations as to abundance as Table 2-17. A transect through Degenhardt Island is included as Figure 2-19, showing a progression of changes from the youngest communities or successional stages at the margin, herbs, changing to young willow, older willow, and finally terminating in a silver maple-cottonwood community.

Klein, et al., (1975), discuss the physiognomy of floodplain vegetation which produces zones which more or less parallel the river. Their diagram (Figure 2-20) may also be construed to show forest succession in the floodplain, communities changing both in relation to time and also to deposition and flooding. If this transect (Figure 2-20) can be taken as a successional picture, then the willow community, which occupies the river-edge, is the pioneer community and is succeeded in turn by a silver maple-cottonwood community and finally by a stable pin oak community.

2.2.2.4. Animal Communities

A total of 416 animals in 84 families were observed or expected to occur in the project area; during field work, the presence of 126 species and subspecies was verified (Terpening et al., 1975). All animals are listed according to habitat type and study site in Appendix C, Table 2-24. Some of the animal species utilizing each community are discussed in this section. These descriptions were not meant to include every species that could occur in the community types, but rather to give the reader an overview of the biological composition of each community.

a. Willow Community.

Except for a few species that are limited to a specific type of vegetation, the animals found in floodplain forests will occur throughout the floodplain regardless of tree species present. Therefore, the animal composition of the five forest types delineated by the Missouri Botanical Gardens (1975) (excluding oak-hickory) would be essentially the same in terms of animal utilization and can be discussed as one unit. As the animal inventory was concentrated in the unprotected floodplain and oak-hickory communities are usually considered dry, upland types, no animal inventory was conducted in the oak-hickory community.

The floodplain forest was an essential habitat for a minimum of 28 mammals ranging in size from the least shrew to the white-tailed deer. The most frequently observed mammals included opossum, fox squirrel, white-footed mouse, raccoon, and white-tailed deer. Evidence of raccoon was most numerous at forest edges adjacent to aquatic habitats; deer sign was also most abundant at the forest edge, particularly along forest-old field edges. The abundance of sign at the junction of two communities, or edge, illustrated the importance of edge in terms of food and cover. It also showed that animals require a diversity of habitats.

Table 2-17

Herbs Collected in the Silver Maple Community
on Degenhardt Island*

Species	Abundance
Amaranthus sp.	Rare[1]
Aster sp.	Rare
Aster simplex	Moderately common[2]
Cynachum laeve	Rare
Eclipta alba	Rare
Eragrostis cilianensis	Rare
Eupatorium serotinum	Rare
Ipomoea lacunosa	Rare
Mollugo verticillata	Rare
Panicum dichotomiflorum	Rare
Pilea pumila	Rare
Polygonum lapathifolium	Rare
Rorippa sessiliflora	Rare
Stachys tenuifolia	Rare
Xanthium pensylvanicum	Rare

[1]Rare = cover value less than five percent

[2]Moderately Common = cover value, in this case, estimated at 16 percent

*FROM: Klein, *et.al.*, 1975.

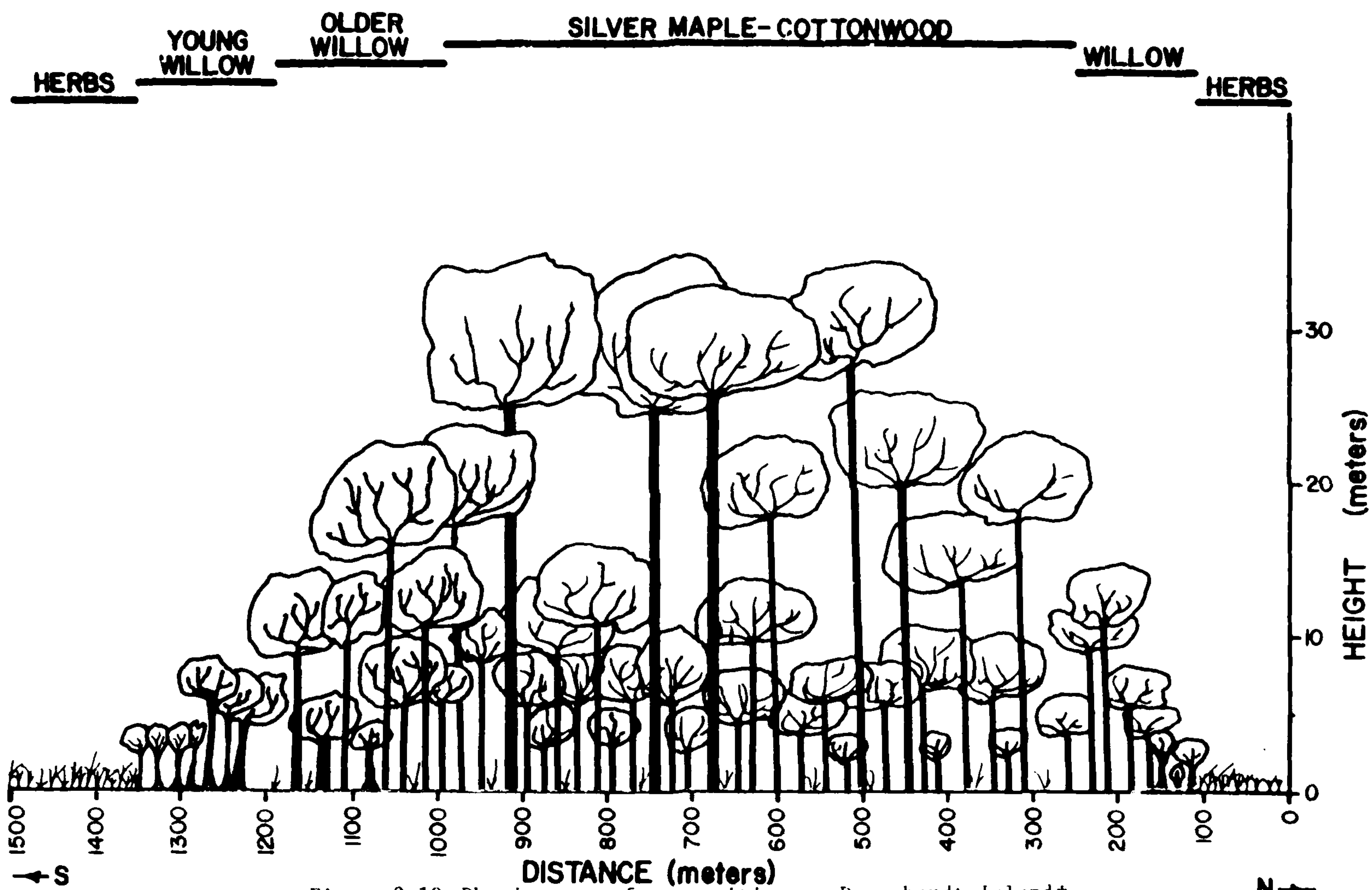


Figure 2-19 Physiognomy of communities on Degenhardt Island*

*FROM: Klein, et.al., 1975.

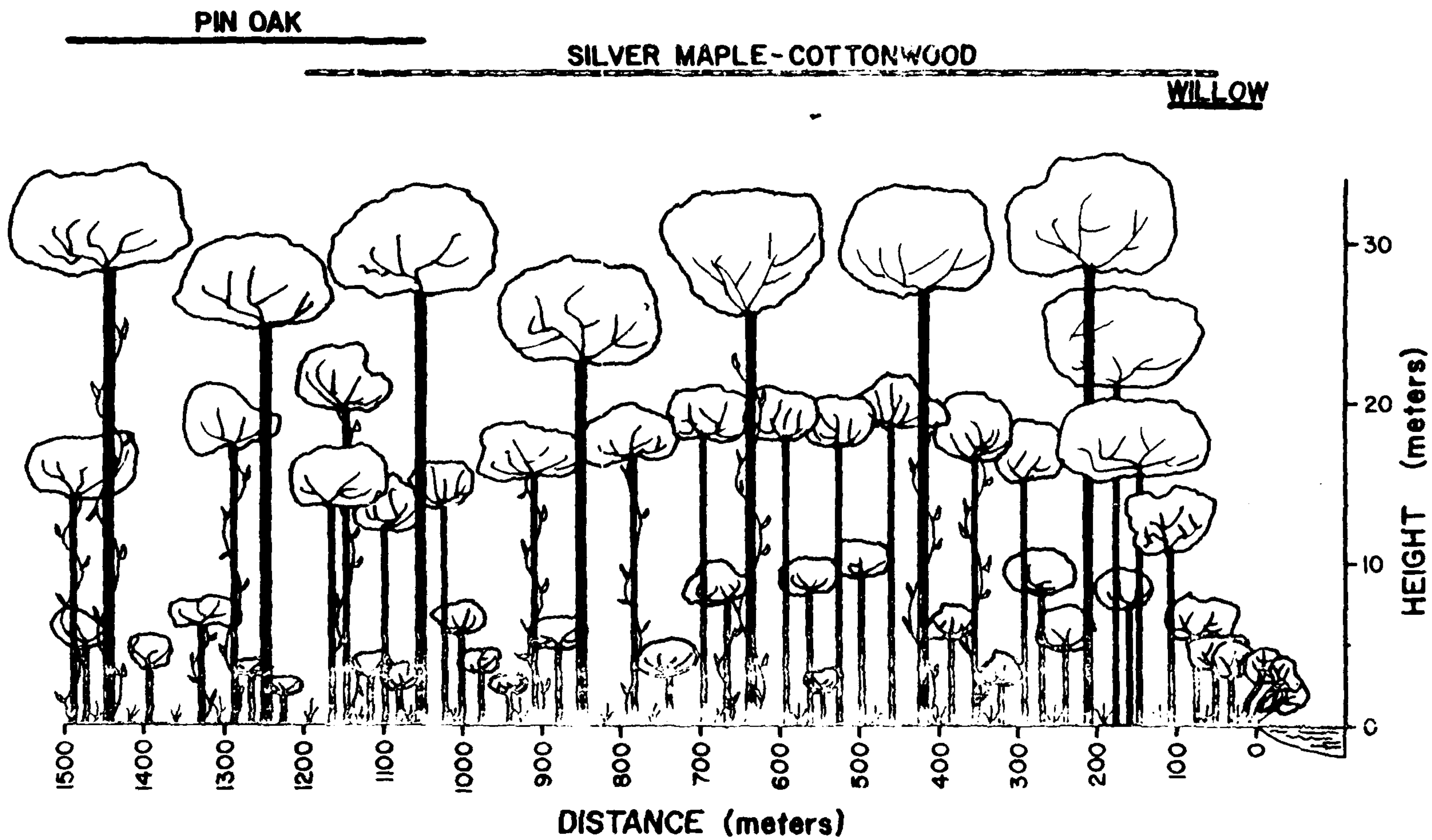


Figure 2-20 Physiognomy of floodplain forest communities *
*FROM: Klein, et.al,, 1975.

Mature floodplain forests provide den trees, stumps, and hollow logs essential for the survival of tree-dwelling species such as squirrels and raccoons; trees are also utilized by several species of bats. Although many species of small mammals commonly inhabit the forest floor, relatively few were captured. In general, low abundance and diversity of small mammals in the floodplain forest was attributed to the destruction of herbaceous vegetation and cover by frequent floods. Unique species expected to occur in the forest of the project area include the bobcat, the Indiana bat, the gray bat, Keen's bat, and the hoary bat.

As many as 142 species of birds were expected to inhabit the forests of the project area; of these, 99 were of the Order Passeriformes (perching birds), which are insect, fruit, and seed eaters. The American robin, blue jay, prothonotary warbler, tufted titmouse, and rough-winged swallow were commonly seen. Birds expected to nest in the woods included great blue and green herons, wood ducks, woodpeckers, owls, hawks, and vultures. Two rare in Illinois birds, Bewick's wren and the brown creeper, were observed feeding in the project area. The rare in Illinois black-crowned night heron and the rare in Illinois hooded merganser may nest in the floodplain forest.

At least 27 species and subspecies of amphibians and reptiles were expected to occur in the floodplain forest. American and Fowler's toads, Blanchard's cricket frog, and leopard frogs were frequently observed around the perimeter of recently flooded shallow depressions and ditches in the forest. Several species of salamanders, including the rare in Illinois dark-sided salamander, and the ground skink were expected to dwell among the leaf litter and debris of the forest floor. Nine species of snakes may inhabit the forest including the rare in Illinois western worm snake and Great Plains rat snake, and the endangered timber rattlesnake. Most of these snakes feed on the small rodents and amphibians of the forest floor.

b. Wetlands.

Five mammal species were expected to occur in wetland habitats. The most abundant wetland species in the project area was the muskrat which depends upon stable water levels, abundant shoreline, and emergent vegetation for food and cover. Other species utilizing this habitat included mink, raccoon, and beaver.

Wetlands were most attractive to swimming and diving birds, wading birds, and shorebirds. These three groups accounted for 74 of the 141 species expected in this habitat. Also, various raptors, such as the marsh hawk, and the red-shouldered hawk, bald eagle, and osprey, may feed on the fish and mammals found there. Thirty-nine passerine species were expected to

occur; among these, the great crested flycatcher, rough-winged swallow, cardinal, and Carolina wren were frequently recorded.

Wetlands provide essential habitats for 21 species of amphibians and 24 species of reptiles. Salamanders, toads, cricket frogs, chorus frogs, tree frogs, bullfrogs, and leopard frogs may utilize both semi-permanent and permanent aquatic habitats for reproduction. The common snapping turtle, painted turtles, red-eared turtles, and map turtles were commonly observed in wetland areas. Four species of water snakes (Genus Natrix) frequently utilized stumps and debris in sloughs.

c. Buildings.

The community termed buildings included any occupied or abandoned structure and its grounds, such as industrial developments, towns, farm buildings, and river-front cottages. The vegetation of these areas generally consisted of selected native trees and a maintained understory and ground cover.

Buildings and their grounds were not an essential community for mammals of the project area. Norway rats, house mice, and several species of bats may utilize buildings.

Fifty species of birds were expected to occur around buildings; 35 of these were passerines. Barn swallows, house wrens, chimney swifts, starlings, and house sparrows were commonly seen.

Few species of amphibians and reptiles occur around residential buildings and industrial developments. Toads, garter snakes, eastern tiger salamanders, and the northern lined snake have been reported from this community.

d. Cultivated Fields.

Land which had been tilled within the present year was termed cultivated field. This community comprised the majority of land area within the protected floodplain.

Major crops were corn, soybeans, and wheat; truck crops (watermelon and cantaloupe) were grown in the extremely sandy soil of the northern section of the Illinois River near Meredosia. Cultivated fields exhibited the least vegetative diversity of all communities in the project area.

The 24 species of mammals associated with cultivated fields were also expected in old field communities. Species expected to occur in cultivated fields were the western harvest mouse, the rare Plains pocket gopher, the woodchuck, Norway rat, coyote, red fox, and spotted skunk.

A minimum of 60 bird species may occur in this community which is utilized more for foraging than for nesting. Passerines common in cultivated fields of the project area were the horned lark, starling, meadowlarks, red-winged blackbird, common grackle, and several sparrows. Species reported to feed in cultivated fields included cattle egrets, geese, dabbling ducks, raptors, and shorebirds such as killdeer, American golden plover, greater yellowlegs, and the upland sandpiper. Game species present were mourning doves, bobwhites, and ring-necked pheasants.

Due to the lack of vegetative diversity, only 19 species of amphibians and reptiles were expected to occur in this community. Fowler's toads and northern and southern leopard frogs were the most abundant amphibians. Occasionally reported were the western smooth green snake and the eastern massasauga.

e. River and Stream Community.

The Illinois and Mississippi rivers were the only two bodies of water designated as river community. All tributaries were designated streams.

Emergent and floating aquatic vegetation was lacking in this community. In restricted areas, elevated sand and mud deposits retarded the current sufficiently to enable vegetation, such as arrowhead (*Sagittaria* spp.), smartweed (*Polygonum* spp.), and American lotus (*Nelumbo lutea*), to exist temporarily during late spring and summer.

Rivers and streams were essential for at least four mammals: beaver, mink, muskrat, and the river otter; all but the river otter were important to the fur trade. All beaver and muskrat dens observed were the bank type.

All birds seen flying over rivers and streams or observed on snags or stumps in the water were placed in this community. Of the 91 species of birds expected to utilize rivers and streams, 51 species were waterfowl, fish-eating raptors and terns, and scavenging gulls and crows. Although 40 passerines were placed in this habitat, many did not actually feed over the water, but they were included due to their preference for vegetation near this habitat. The rough-winged swallow, common grackle, common crow, red-winged blackbird, and indigo bunting were frequently observed.

Twenty-six species of amphibians and reptiles were expected to occur in this aquatic community. The bullfrog and leopard frog utilize brush piles and vegetation near the banks where there was less current. Spotted, red-backed, long-tailed,

and dark-sided salamanders may occur in floodplain steams. Midland painted, map, and red-eared turtles were observed in both quiet and swiftly-moving sections of the rivers. Three species of water snakes may also be expected in this community.

f. Sandbank and Mudflat Community.

Sandbanks and mudflats represented land that was newly formed or was uncovered by the recession of water; they were closely associated with rivers, streams, and certain wetland areas. These areas were also found near lakes, and downstream from wing dikes. Temporary sandbanks created by dredging operations were usually located within the river channel. Mudflats formed around the edges of sloughs, lakes, and ponds as these wet areas dried.

Vegetation associated with the mudflats was more diverse than that associated with sandbanks. Herbaceous vegetation consisted of annual grasses, composites, and sedges. Elevated sandbanks and mudflats supported seedlings and small saplings of willow, cottonwood, sycamore, and silver maple. This habitat type was subject to frequent inundation, and, unless the seedlings were large enough to resist dislodgment during periods of high water, the existing vegetation was destroyed.

Tracks of opossum, raccoon, muskrat, beaver, mink, and deer were common on the sandbanks and mudflats. Following a drop in water level, raccoons were observed foraging for mussels on exposed flats. The frequent inundation and lack of vegetative cover severely restricted small mammal populations in this community.

Sandbanks and mudflats were most important to shorebirds; 25 of the 50 expected species were of this group. This community was a source of crustaceans, insects, and other food items. The least tern has been reported as breeding on sandbanks in the Mississippi River (Anderson and Bauer 1968). Great blue and Louisiana herons and glaucous and herring gulls may utilize the habitat as resting sites and forage for food along the shore. Crows, turkey vultures, cardinals, common grackles, and swallows frequented this community.

Sandbanks and mudflats may be utilized by at least 26 species of amphibians and reptiles. Fowler's toad was the most abundant amphibian; juvenile toads and cricket frogs were frequently observed in deep cracks of the drying mudflats. The rare Illinois chorus frog has been reported from the sandy floodplain along the middle Illinois River (Smith 1961). Several aquatic turtles including soft-shelled turtles, the more common map turtles, painted turtles, and red-eared turtles, as well as the Blanding's turtle, and three rare turtles (Illinois mud turtle, the mud turtle, and slider), utilize this habitat for basking and egg-laying.

g. Old Field.

The greater vegetative diversity of old field areas was reflected in the large number of mammals (32) expected to occur there. Small mammals typically associated with old fields included the western harvest mouse, deer mouse, prairie mole, house mouse, least shrew, and the meadow jumping mouse. Old field areas were the most productive habitat type for small mammals. Opossums, fox squirrels, raccoons, eastern cottontails, striped skunks, and white-tailed deer were also observed.

Some of the more common birds utilizing this habitat were the rough-winged swallow, barn swallow, house sparrow, northern oriole, common grackle, cardinal, and indigo bunting. The 123 expected species included the western kingbird, loggerhead shrike, marsh hawk, long-eared owl, short-eared owl, and saw-whet owl, and the sharp-shinned hawk, Cooper's hawk, and red-shouldered hawk. The large number of hawks and owls in this habitat reflects the abundance of small mammals, a main food source for these raptors. Game birds present were the bobwhite, ring-necked pheasant, woodcock, and mourning dove. In general, old fields provided food sources and nesting areas for birds.

Thirty-three species of amphibians and reptiles were expected to occur in old fields. American and Fowler's toads and two subspecies of leopard frogs were the most abundant amphibians, particularly along the borders of levees during floods. Six-lined racerunners were common on sandy levees. Common snakes of this habitat included the black rat snake, eastern garter snake, kingsnakes, and the red milk snake.

2.2.2.5 Effects of Periodic Inundations on Floodplain Fauna

Periodic inundation (flooding) is a natural phenomenon occuring annually, or semiannually, within the vicinity of all rivers and streams. The area bordering rivers and streams, and, therefore, the area most likely to be inundated, is termed the floodplain.

Spring and early summer floods are potentially the most hazardous to wildlife because they threaten spring litters and broods and increase the vulnerability of displaced individuals, especially immature animals. Extremely vulnerable are the litters of bank-dwelling beavers and muskrats, as well as the many mammals which inhabit underground burrows, and the ground-nesting birds.

The less direct, more subtle effects of flooding are those which influence animal populations through alteration of vegetative composition, either temporarily or permanently. Loss of herbaceous vegetation, ground cover, and food supplies due to siltation results in the temporary displacement and delay in reestablishment of certain mammals, reptiles, and amphibians. In some cases, deposition of flood debris may provide additional food and cover in an otherwise barren, silt-smothered forest floor. Permanent changes in the vegetative community due to frequent, extensive, or permanent flooding results in permanent changes of the associated animal community.

Field observations of animal sign after the 1974 spring flood waters receded revealed that raccoon and white-tailed deer were the first large mammals to reinvade the unprotected floodplain (Terpening et al., 1975). It appeared that the white-footed mouse was the first small mammal to return. Since birds are not confined to the ground, the flooding had relatively no effect on the species present, although it may have affected their nesting habits. Amphibians and reptiles, concentrated along the levees during the high water, returned to areas of permanent water.

In general, the effects of flooding on flora and fauna are extremely variable, depending upon the time, extent, and duration of the flooding. The total effects of these factors are also dependent upon the species involved, particularly their ability to adapt to flooding and upon their individual habitat requirements. Any detailed assessment of flooding requires a species-by-species approach, evaluating the interrelationships among all variables involved.

2.2.2.6. Importance of Floodplain Wildlife

a. Economic Importance.

The economic importance of wildlife living in the floodplain is related primarily to its value as a recreational form. Hunting and trapping expenditures in the counties of the study area were estimated at $6.8 million per year (Appendix C, Tables 27, 28, 29, 37, 39, and 40); the value of other nature-related recreational activities, or nonconsumptive uses, such as hiking, nature photography, and bird watching, was estimated at $3.7 million per year for the divisions of the Mark Twain National Wildlife Refuge in the study area (Appendix C, Table 41).

(1) Hunting.

Four types of animals were hunted in the study area: small game mammals, white-tailed deer, upland game birds, and

waterfowl. Harvest data were available only on a county basis and, in some cases, only on a regional level. As the area of floodplain and the quality of habitat varied among counties, it was not feasible to further define the data into a "study area only" segment. For those animals, such as waterfowl, which are almost exclusively limited to aquatic habitats, the county harvest statistics were reasonably representative of the study area. Only those animals known to be well represented in the floodplain were included in the discussion of hunting and trapping.

Seven species of small mammals were hunted in Illinois and Missouri: rabbit, fox squirrel, gray squirrel, woodchuck, raccoon, red fox, and gray fox. Rabbits and squirrels constituted the majority of the small game mammal harvest (Appendix C, Table 25 and 26). In the study area, an estimated $3.5 million was spent by hunters of small game mammals (Appendix C, Table 27).

White-tailed deer were common in the study area, where they utilized a variety of habitats from bottomland forests and sloughs to cultivated fields. In 1973, more than 2,500 deer were harvested in the counties of the study area at an annual expenditure of approximately $939,712 (Appendix C, Table 28).

Six major species of upland game birds were hunted in Illinois and/or Missouri: American woodcock, wild turkey, bobwhite, ring-necked pheasant, mourning dove, and common crow. The bobwhite and the mourning dove were the major species harvested (Appendix C, Tables 30, 31, and 32). An estimated $1.8 million was spent annually in the counties of the study area by upland game bird hunters (Appendix C, Table 29). Other game species occurring in the research area, for which no harvest data were available, included the common snipe, common gallinule, sora, and Virginia rail.

Illinois is considered a leading state in the nation for migratory waterfowl (Bellrose and Crompton 1970), and the study area lies within the Mississippi Flyway, which is used by millions of waterfowl each spring and fall (Appendix C, Tables 33, 34, 35, and 36). During the 1972 hunting season, more than 77,000 ducks, geese, and coots were harvested in the study area. Of these, dabbling ducks, principally the mallard, constituted more than 50 percent of the total harvest; diving ducks, mainly the lesser scaup, accounted for about six percent of the waterfowl harvested (Appendix C, Table 38). In 1972, 7.2 percent and 0.5 percent of the waterfowl harvested in Illinois were Canada geese and lesser snow geese, respectively; in Missouri, these species made up 15 percent and five percent of the harvest. Mergansers, coots, and white-fronted geese each comprised less than one percent of the total harvest. Waterfowl hunters utilized sandbars and islands in the Mississippi River, conservation areas

managed for controlled hunting, or private duck clubs. In 1972, approximately $1.2 million was spent by waterfowl hunters in the counties of the study area (Appendix C, Table 37).

(2) Fur Trapping.

While harvest of furbearers has declined since the peak period of the 1940's, current harvests have attained all-time record values due to increased demand and higher prices for most pelts (Sampson 1974). Bottomland species of greatest economic importance included raccoon, muskrat, opossum, and mink; additional furbearers of lesser economic importance were beaver, skunk, weasel, fox, coyote, bobcat, and badger. Fur harvest for the 1973-1974 season amounted to an estimated $119,300 in the Illinois counties of the study area (Appendix C, Table 39) and $116,300 in the Missouri counties (Appendix C, Table 40).

(3) Nonconsumptive Uses.

Nature interpretation, wildlands appreciation, photography, hiking, and wildlife observation are recreational activities considered nonconsumptive uses of wildlife resources, as they do not involve the "harvest" of any animal. The economic value of such activities is difficult to assess, and little research has been done, largely due to the dominant interest in the recreational aspects of hunting and fishing. A survey was conducted in 11 southeastern states in 1972 which asked 23,577 citizens to place a monetary value on each day spent in wildlife-related recreation (Horvath 1973). This value represented the amount each citizen felt the wildlife-related recreation was worth, considering all benefits associated with the activity, and did not reflect the amount the citizen would actually pay. Participants valued observation and photography of fish and wildlife at an average of $70.56 per day. Utilizing this value, nonconsumptive recreation in the Mark Twain Refuge of the study area was assessed at more than $3.7 million for the year 1973 alone (Appendix C, Table 41).

b. Scientific and Aesthetic Importance.

Four wildlife refuges and management areas covering more than 54,000 acres were located in the study area: Mark Twain National Wildlife Refuge, Upper Mississippi River Management Area, Mississippi River Fish and Waterfowl Management Area, and the Ted Shanks Memorial Refuge. These refuges contained relatively undisturbed areas for scientific study. Animal groups of particular scientific interest in the study area included endangered and threatened species, species living on the periphery of their expected range, intergradations of populations, and relict populations.

2.2.2.7. Pestiferous Plants and Animals

a. Plants.

Of the 324 species of plants listed by Klein, et al., (1975), several might be construed as pestiferous, as follows: Poison Ivy, *Rhus radicans* L., produces a substance which causes skin irritations in varying degrees following contact. The genera *Bidens*, *Xanthium*, *Desmodium*, and *Geum* all produce fruits which cling to clothing by various hooking devices. The genus *Spartina* has serrate leaf margins which cut. The genus *Laportea* has stinging epidermal hairs on leaves and stems whereas the genera *Rubus* and *Crataegus* have prickles or spines on their stems. The genus *Cirsium* has spiny leaves. Members of the genera *Amaranthus*, *Convolvulus*, *Digitaria*, *Setaria* and various Cyperaceae may be pestiferous weeds in agricultural fields, as can be *Digitaria*, *Rumex*, various Cyperaceae, *Plantago*, and *Stellaria* in lawns and yards. In addition to these, many species are known to be toxic if ingested.

b. Animals.

Many of the vertebrate species inhabiting the floodplain are important public health concerns due to their role as natural or aberrant hosts of zoonoses or as their vectors. Wildlife-related diseases of public health importance which may occur in the study area are: rabies, tularemia, Rocky Mountain spotted fever, salmonellosis, leptospirosis, brucellosis, and histoplasmosis. Except for rabies, records on these diseases are available only on a state basis; therefore, the incidence of their occurrence in the study area is difficult to judge. In 1973, less than 70 cases of these diseases, excluding rabies, were recorded in Illinois and Missouri (Appendix C, Table 42).

Appendix C, Table 43 list the known animal rabies cases reported from the river counties of Illinois and Missouri in the past 10 years. Skunks and foxes are the main carriers of rabies among wildlife in Illinois (Schnurrenberger et al., 1969). Bats, particularly the red bat, big brown bat, and hoary bat, are becoming more widespread as vectors (Illinois Dept. of Public Health 1967a and 1967b); several species have been identified as symptomless hosts of rabies virus (Burns et al., 1956).

A few other diseases may be conveyed to the public by wild animals. Appendix C, Table 44 lists those diseases which would not presently be considered a likely hazard in the unprotected floodplain, but which are transmitted by wildlife and which, under certain conditions, could become health concerns.

Three species of poisonous snakes may be found in the floodplain, all belonging to the family Crotalidae: timber rattlesnake, northern copperhead, and eastern massasauga (Smith

1961). An average of 14 people die from snakebite each year in the United States (Parish 1963 in Burkett 1966) out of 5,000 bitten (Burkett 1966). Timber rattlesnakes cause the most serious bite. More people are bitten by copperheads than by any other poisonous snake in Missouri, but the fatality rate is less than one percent (Anderson 1965). No deaths from snake-bite were reported by Smith (1961) in Illinois, or by Anderson (1965) in Missouri. Poisonous snakes are infrequently encountered by people using the floodplain.

At least 32 families of invertebrates which may be of public health concern occur in the study area. An annotated checklist of these invertebrates is included in Appendix C, Table 45.

2.2.3. THREATENED, RARE, AND ENDANGERED SPECIES

2.2.3.1 General

Lists of rare, threatened, and endangered species have been prepared by various groups of interested persons, including various taxa of plants and animals, and for various geographical regions. These lists have been consulted for possible presence of such species in the proposed project area. Among these are: United States List of Endangered Fauna (U.S. Department of the Interior, 1974; Report on Endangered and Threatened Plant Species of the United States (Smithsonian Institution Serial #94-A, 1975); Rare and Endangered Species of Missouri (Missouri Department of Conservation and U.S.D.A., Soil Conservation Service, 1974), and Rare and Endangered Vertebrates of Illinois (Illinois Nature Preserves Commission Two-Year Report, 1971-1972).

Of concern are not only threatened, rare, and endangered species, but also the integrity of the ecosystems upon which these depend.

2.2.3.2 Terrestrial Plants

One rare community was discovered by Klein, et al., (1975): the terrace oak-hickory community. Although no threatened, rare, or endangered species were found there, the particular combination of species has produced a unique bottomlands community which has not been previously reported and which deserves protection on its botanical merits.

Klein, et al., (1975), compiled a list of rare and endangered species which might be found in the project area along with the habitats in which they might be expected (Table 2-18). They found none of these except the genus Ulmus in their collections. This genus is threatened by Dutch Elm disease but is by no means rare. The other species listed were considered by Klein, et al., (1975), to be unlikely to be found in floodplain locations due to their habitat specificities. The disturbances on floodplains, which are considered unstable, favor more weedy species tolerant

of instability. None of the possibly occurring rare and endangered species of Klein et al., (1975), (Table 2-18) are listed as endangered or threatened for Illinois or Missouri in Report on Endangered and Threatened Plant Species of the United States (1975). This same report was cross-checked with Table 23. Plants Collected in 1974. No positive findings of endangered species occurred. However, three threatened species are worthy of further discussion:

Compositae: Boltonis asteroides var. decurrens, threatened in Missouri and Illinois

Gramineae: Muhlenbergia curtisetosa, threatened in Missouri and Illinois

Rosaceae: Rubus missouricus, threatened in Missouri.

The study area was found to contain Boltonia asteroides, Muhlenbergia spp., and Rubus spp. None of these collected species are positive match-ups to the above threatened species, but neither can they be dismissed as being totally different.

2.2.3.3 Aquatic Invertebrates

The Endangered Species Act of 1973 (P.L. 93-205) authorizes and directs the Department of the Interior to determine which species of mollusks and crustaceans are "threatened species" or "endangered species" as defined by the Act, and to take whatever measures may be necessary to insure the survival of such threatened or endangered species.

Table 2-18

Habitats of Rare and Endangered Plant Species in Missouri

Shining Clubmoss, Lycopodium lucidulum Michx. var. lucidulum

Grows best in LaMotte and St. Peter sandstone; unlikely in the Mississippi or Illinois River floodplains.

Cut-leaved Grape Fern, Botrychium dissectum Spreng. var. dissectum

Generally requires more mesic sites, such as woodland ravines and valleys, than are to be found in the floodplain.

Adder's-tongue, Ophioglossum vulgatum L. var. pycnostichum Fern.

Associated with lowland woodlands; could be found in any of the floodplain habitats, unlikely in the willow forest or old fields.

Ditch Grass, Ruppia maritima L. var. rostrata Agardh.

Probably not found in the study area.

Small Spike-rush, Eleocharis parvula (R.& S.) Link var. anachaeta (Torr.) Svenson

Unlikely in the study area.

Arrow Arum, Peltandra virginica (L.) Schott & Endl.

Could be found in any of the bottomland habitats (except old fields) as it occurs in wet ground adjacent to sloughs and oxbow lakes; unlikely however, in the willow community adjacent to the rivers.

Elms, Ulmus spp.

Species can be found in nearly all habitats in the floodplain; considered endangered due to Dutch Elm disease and its disappearance will certainly have an impact on the plant communities in the study area.

Rose Turtlehead, Chelone oblique L. var. speciosa Pennel & Wherry

May occur in any of the bottomland habitats except old fields.

Source: Rare and Endangered Species of Missouri (Missouri Department of Conservation and U.S. Department of Agriculture, 1974).

The Fish and Wildlife Service has published a list of mollusks and crustaceans in the Federal Register (17 October 1974) which may be threatened species or endangered species as defined by the Act and is now initiating a thorough review of the status of each in order to determine the actual classification of each species. One species of mussel, Lampsilis higginsi, which has been reported from the Upper Mississippi River, is found on this list and was also previously on a list of rare and endangered mollusks of the United States, as published by the U.S. Bureau of Sport Fisheries and Wildlife in 1972.

Of the states in the study area, Missouri is the only one with a list of rare and endangered species that includes aquatic invertebrates. However, none on that list have been reported from the Upper Mississippi River.

2.2.3.4 Aquatic Vertebrates

One species of fish on the U.S. list of threatened species, the lake sturgeon, occurs within the riverine reaches of the project area. It was reported to be abundant in the commercial harvest during the late 1800's, then it underwent a rapid decline in abundance during the early 1900's. The construction of locks and dams has been suggested as a possible reason for part of the decline; however, overfishing has been suspected as the major reason for the decline.

The lake sturgeon is included on both the Illinois (rare) and Missouri (endangered) state "rare and endangered species" lists. Four other species of fish that occur in the project area, the brassy minnow, blue sucker, brown bullhead, and burbot, are included on the State of Missouri rare and endangered species list. Construction of locks and dams has been suggested as part of the reason for a decline in abundance of the blue sucker since the early 1900's. The other three species were probably never abundant in the riverine reaches of the project area.

2.2.3.5 Terrestrial Invertebrates

Although the list of rare and endangered species of Missouri includes invertebrates, the State of Illinois has not yet adopted such a listing. Because of the complexity of this group, and the lack of information pertaining to individual species diversity and distribution, no attempt has been made to identify rare and endangered invertebrates for the purpose of this report.

2.2.3.6 Terrestrial Vertebrates

Species in the study area considered rare or endangered in Illinois and/or Missouri included nine mammals, 22 birds, and 15

amphibians and reptiles. The Indiana bat, southern bald eagle, and peregrine falcon were also on the Federal endangered species list. Most of these animals were so categorized due to habitat destruction, particularly the drainage of marshes and sloughs. The status of the threatened animals in Illinois, Missouri, and the nation is given in Appendix C, Table 46. A. The number of bald eagles wintering on the Mississippi River (Navigation Pools 24, 25, and 26) and on the lower Illinois River from 1965 to 1974 is shown in Appendix C, Table 47. Most bald eagles in the study area are probably northern, but it is not possible to tell from a distance. A discussion of the habitat requirements of these species is included in Appendix D.

2.3 SOCIO-ECONOMIC CONDITIONS

2.3.1. DEMOGRAPHIC CHARACTERISTICS

2.3.1.1. Population

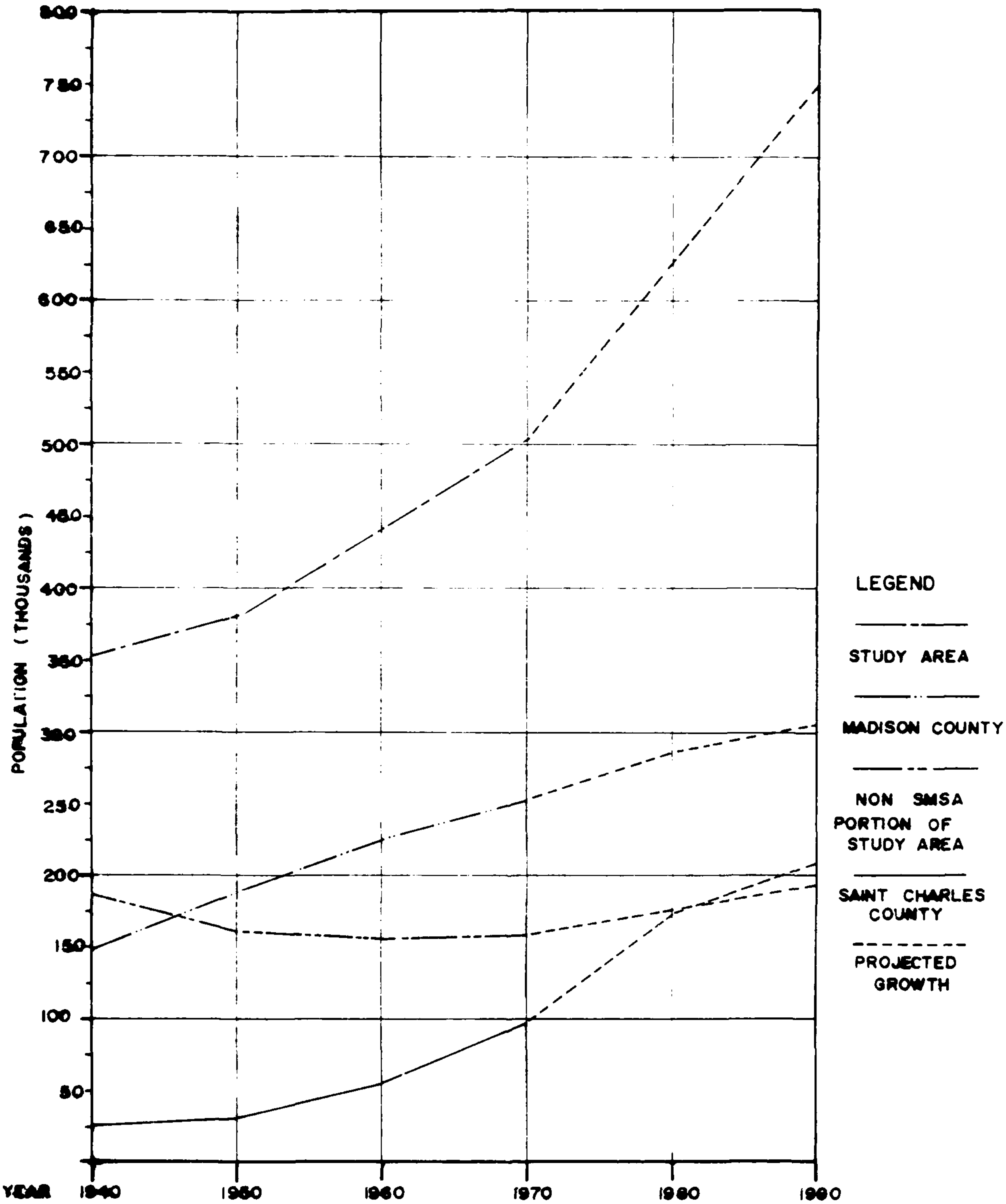
a. Upper Mississippi Region. The Upper Mississippi Region includes parts of the states of Illinois, Missouri, Iowa, Wisconsin, and Minnesota (Plate 5). This region has been defined by the Water Resources Council and the U.S. Department of Agriculture, Office of Business Economic Research Services (OBERS) on the basis of major drainage patterns. The region contains 17 Standard Metropolitan Statistical Areas (SMSAs), which include the St. Louis, Des Moines, Minneapolis-St. Paul, Madison SMSAs, and part of the Chicago SMSA. In 1970 the population of this region was 12.84 million. During the years from 1950 to 1970 the Upper Mississippi Region has grown at a slower rate than the United States as a whole. The rate of population increased for the Upper Mississippi Region for 1950 to 1970 was 22.4 percent compared with 34.3 percent for the nation.

b. Study area. The study area consists of the Missouri and Illinois counties contiguous to the Mississippi and Illinois Rivers between river miles 195.0 and 312.5 on the Mississippi and 0.0 and 80.0 on the Illinois.

In 1970 the population of the study area was 509,062. Over the past three decades the population of the study area has increased 43 percent. This growth has been almost entirely centered in the two counties--St. Charles and Madison--which are part of the St. Louis SMSA. Figure 2-21 illustrates the character of population growth in the study area.

As the graph indicates the other counties in the study area taken as a group have experienced a decline and then a stabilization of population over the past 30 years. In the Illinois portion of the study area, seven of nine counties lost population between 1960 and 1970; in Missouri one of the four counties lost population.

FIGURE 2-21. Population growth, historical and projected, 1940 - 1990.



SOURCES: U. S. CENSUS OF POPULATION, 1950-1970; STATE OF MISSOURI OFFICE OF COMPTROLLER AND BUDGET DIRECTOR, STATE OF ILLINOIS, OFFICE OF PLANNING AND ANALYSIS.

While overall the non-SMSA counties in the study area have not experienced population growth, many of the larger towns have. In the Illinois non-SMSA counties, twelve of the 14 towns having populations of 1,000 or larger experienced an increase in population during the 1960-1970 decade. In Missouri three of the five towns having populations greater than 1,000 increased their population during this decade. Table 2-19 presents the figures for population growth for the aggregated Missouri and Illinois towns in the SMSA and non-SMSA counties.

Table 2-19

Population Growth in Large Towns, 1960-1970

Place	Population 1970	Population 1960	Percent Change 1960-1970
Missouri			
Non-SMSA Counties	18,423	13,976	31.8
SMSA County	42,075	27,701	51.9
Illinois			
Non-SMSA Counties	50,396	43,611	15.6
SMSA County	40,961	44,278	-7.5

Source: U.S. Census of Population, 1970.

2.3.1.2 Spatial Distribution

The population of the non-SMSA counties in the study area is predominately rural in character of the SMSA counties, Madison in Illinois, has a predominately urban population, while in St. Charles County, Missouri, the majority of residents live in rural locations. In the study area counties, as agriculture has declined in labor intensiveness the percentage of the population engaged in farming has declined. Table 2-20 presents information on the percentage of study area residents living in urban and rural locations, and shows the decline in rural farm population that has occurred.

Table 2-20

Rural-Urban Residence, 1960 and 1970

Place	1970	1960
	Urban Residence (percent)	
Missouri	70.1	66.6
Non-SMSA Counties	24.1	17.7
St. Charles County	48.5	52.3
Illinois	83.0	80.7
Non-SMSA Counties	38.6	36.1
Madison County	71.7	71.8
	Rural Non-Farm Residence (percent)	
	1970	1960
Missouri	22.2	20.9
Non-SMSA Counties	52.4	48.2
St. Charles County	47.5	38.0
Illinois	13.1	13.7
Non-SMSA Counties	42.1	39.2
Madison County	25.2	24.2
	Farm Residence (percent)	
	1970	1960
Missouri	7.7	12.5
Non-SMSA Counties	23.5	34.0
St. Charles County	4.0	9.7
Illinois	3.9	5.6
Non-SMSA Counties	19.3	24.7
Madison County	2.8	4.0

Source: U.S. Census of Population, 1960 and 1970.

The differences between St. Charles and Madison Counties, and the non-SMSA counties in the study area in terms of distribution of population is further shown by comparing population densities. As Table 2-21 demonstrates, the non-SMSA counties have average population densities below those of St. Charles and Madison Counties, and below those of their respective state averages.

Table 2-21

Population Density, 1970

Place	Density (Persons/Square Mile)
Missouri	68
Non-SMSA Counties	24
St. Charles County	169
Illinois	199
Non-SMSA Counties	35
Madison County	342

Source: U.S. Bureau of the Census. County and City Data Book, 1972.

2.3.1.3 Age Structure

The differences noted between SMSA counties and other counties in the study area with regard to population growth are also apparent in terms of age structure. At the time of the 1970 census the median age for the SMSA counties was 26.8 years while for the non-SMSA counties the figure was 30.8 years. These figures compare with the median ages for the states of Missouri and Illinois of 29.4 and 28.6 years respectively.

An examination of the age structure of the study area population in 1950 and 1970 shows shifts in proportionate distribution of population among age groups has occurred. Figures 2-22 and 2-23 show population pyramids for the Missouri and Illinois portions of the study area.

As can be seen there has been a decline in the proportion of the under five cohort in the entire study area. This occurrence parallels a national trend of declining birthrates. Comparisons of population in 1950 and 1970 age groups between non-SMSA counties and the SMSA counties indicate that proportionately population has declined in the middle age cohorts in the Missouri non-SMSA counties and in all Illinois study counties. In contrast, St. Charles county, one of the most rapidly growing counties in the United States, has experienced a proportionate increase in almost all of the age cohorts from age five to 44.

These data suggest that the non-SMSA counties in the study area, as well as Madison County have stabilized in population growth and in addition have experienced some degree of outmigration of the middle segments of their populations. St. Charles County, as a growth center, has attracted many additional residents over the past two decades. Most of these residents have been young and consequently the proportionate age structure of this

FIGURE 2-22. Age structure, Missouri study area, and State of Missouri, 1950 and 1970.

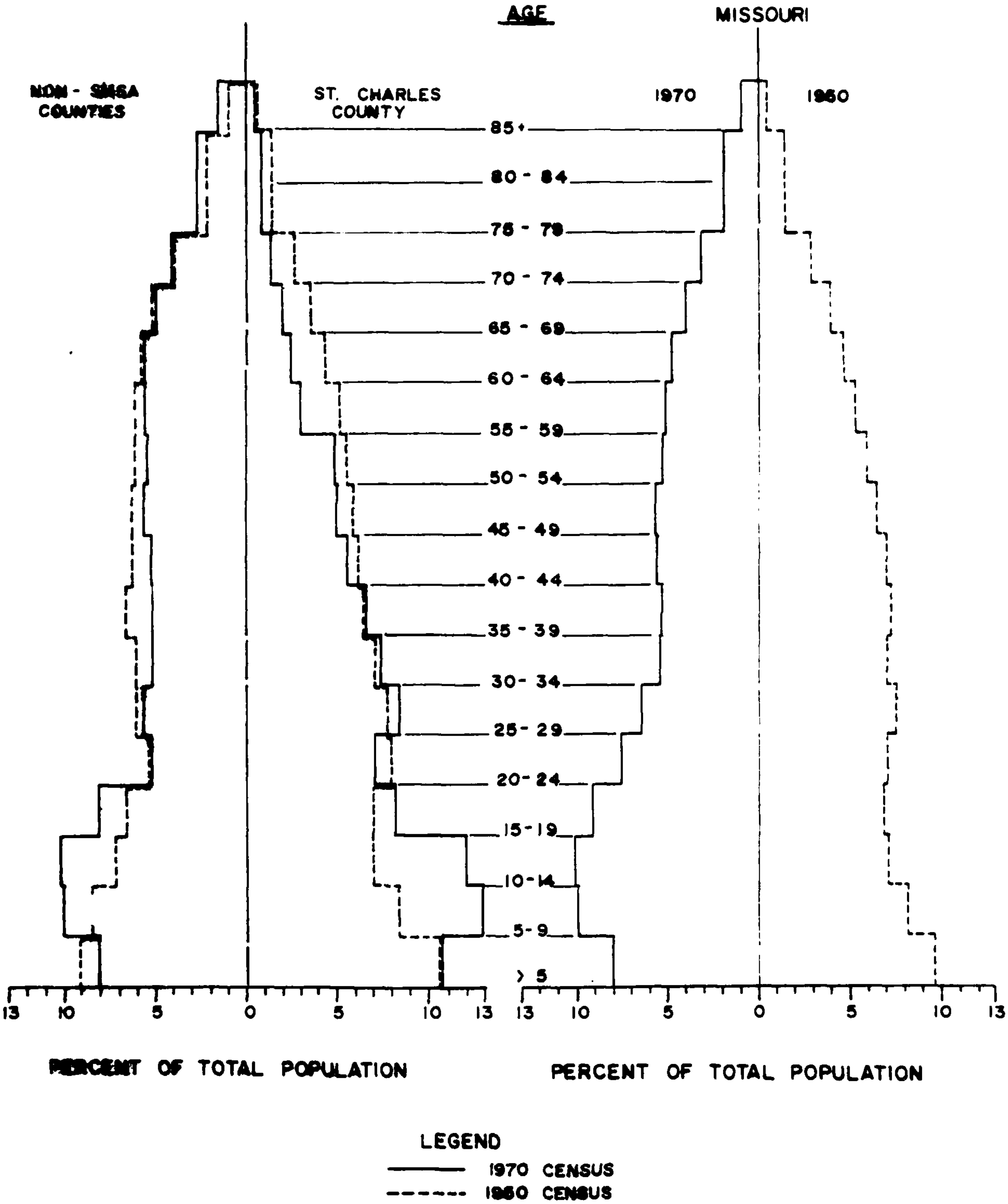
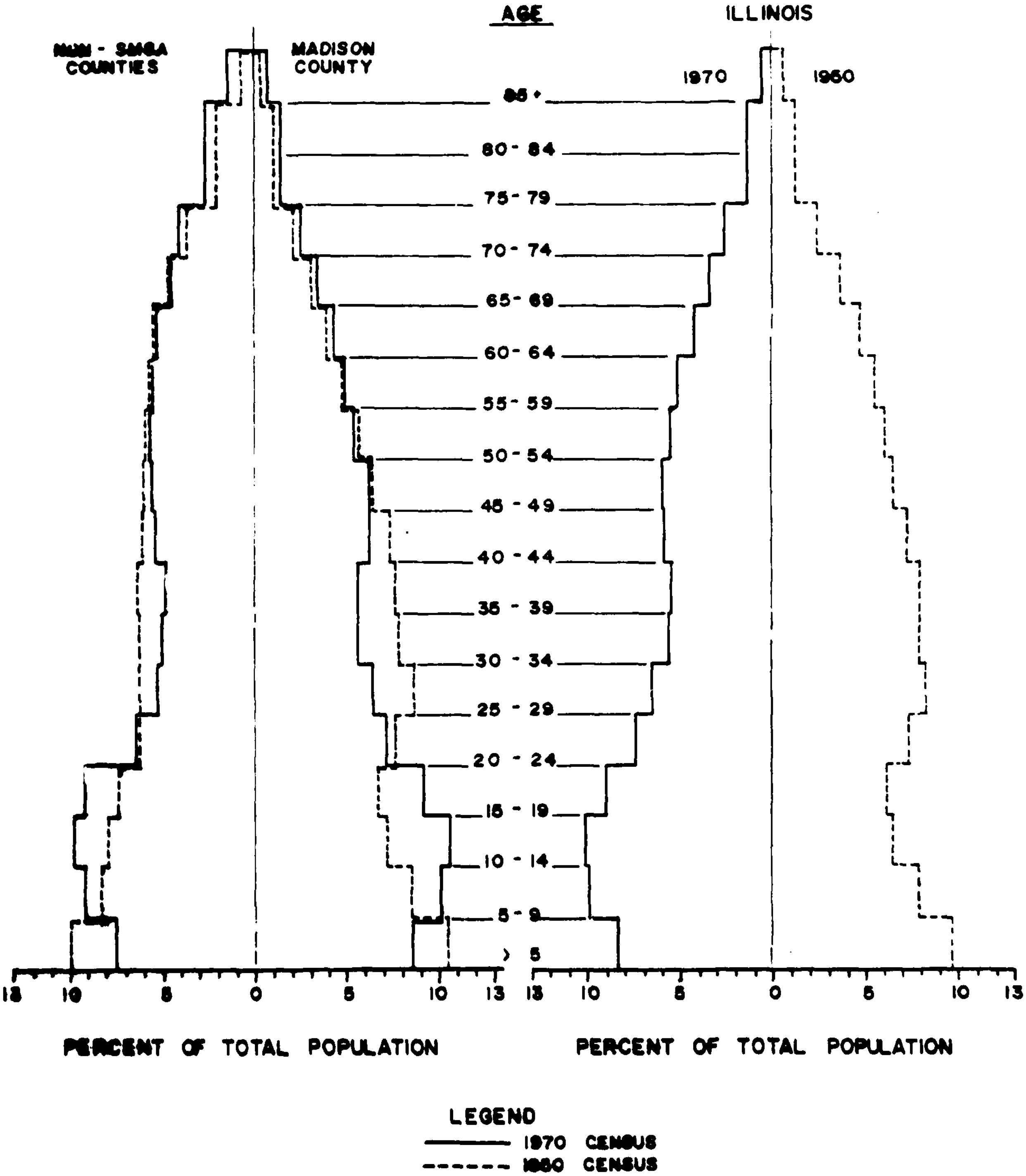


FIGURE 2-23 Age structure, Illinois study area, and State of Illinois, 1950 and 1970.



county has changed in this direction.

2.3.1.4 Migration

Net migration figures for 1970 substantiate the conclusion that outmigration has occurred in most of the study area counties. As Table 2-22 shows between 1960 and 1970, nine of the 13 study area counties had negative net migration totals. Again the SMSA counties account for two of the counties which experienced net migration. In addition, the other two counties that had net inmigration, Lincoln County in Missouri, and Jersey County in Illinois are contiguous to the SMSA counties. This fact suggests there may be some spillover into these counties from the St. Louis metropolitan area as it expands.

Table 2-22

Net Migration, 1960 to 1970

Counties	Net Migration (percent)	Illinois Counties	Net Migration (percent)
Lincoln	16.6	Cass	-6.0
Pike	-3.3	Brown	-10.7
Ralls	-6.1	Calhoun	-11.2
St. Charles	50.3	Green	-5.8
		Jersey	.9
		Madison	.5
State			
Missouri	.05	Morgan	-5.7
Illinois	-.4	Pike	-9.1
		Scott	-8.8

Source: U.S. Census of Population, 1970.

2.3.1.5 Racial Character

The counties in the study area are marked by relatively homogenous racial populations. All counties have fewer non white residents than their respective state averages. Negroes compose almost 100 percent of the non white population in the counties, although American Indians and other groups are also represented. The ratio between whites and blacks has not markedly changed in recent years.

2.3.1.6. Future Trends

a. Upper Mississippi Region. This region is expected to experience continued growth, increasing in population by 17 percent between 1970 and 1990 (Obers, 1972). This rate of increase would be slower than during the previous 20 years and would be substantially below the anticipated national rate of population increase of 33 percent.

b. Study Area. The study area is expected to continue to experience population growth. Population forecasts prepared by departments of the Missouri and Illinois State governments predict that population in the study area will increase approximately 43 percent between 1970 and 1990. (See Figure 2-21)

Most of the growth is expected to occur in the urban counties. Whereas St. Charles County and Madison County now hold 68 percent of the population, by 1990 they are anticipated to contain 73 percent of the population. In Madison County most of the population increase will be from natural increases, while in St. Charles County inmigration of new residents will account for most of the expected growth.

The non SMSA counties considered in aggregate are expected to experience some population increase in the coming decades, however increases are expected to be small, averaging less than one percent a year. It can be expected that most of the growth that does occur will center on or around the towns in the counties. Outmigration of younger groups has been and will continue to be a problem for these rural counties. As a result of outmigration, the proportion of the over 65 may increase relative to other age groups. In both SMSA and non-SMSA counties the continued decline of rural farm population is anticipated, while continued urbanization and suburbanization of the population is predicted.

2.3.2 INCOME AND EMPLOYMENT

Median family income for the non-SMSA counties in 1969 was $7,890, considerably lower than the figure of $10,423 for the SMSA counties. Proportionately twice as many families in the non-SMSA counties had 1969 incomes below the poverty level as did families in the SMSA counties (13.0 percent versus 6.4 percent). The unemployment rate at the time of the 1970 Census for non-SMSA counties was 3.3 percent while the rate for the SMSA counties was 5.5 percent.

2.3.3 INDUSTRY AND OCCUPATION

Clear differences are apparent between the non-SMSA and SMSA counties with regard to the industrial and occupational distributions present in the areas (these differences are primarily representative of the rural-urban differences between the two areas). Table 2-23 presents 1970 employment by industry and Table 2-4 compares the occupational distributions of the two areas. As these tables indicate, the greatest differences between the two areas are in terms of manufacturing and agricultural employment. The SMSA counties are clearly manufacturing centers, while the non-SMSA counties are much more heavily devoted to agriculture. Oçcupations in the SMSA counties are more heavily oriented to white collar employment in professional and clerical categories. Craftmen account for a substantially greater proportion of the occupational distribution of the SMSA counties--no doubt bearing some relation to the preponderance of manufacturing in these counties. Farm workers comprise the only occupational category where the non-SMSA counties have a significantly larger proportion of work force employed.

Table 2-23

Employment by Industry

	Non-SMSA	SMSA
Agriculture, Forestry, Fisheries, Mining	15.7	2.1
Construction	6.8	5.9
Manufacturing	22.0	35.1
Transportation	3.3	4.7
Communications and Public Utilities	3.1	2.8
Wholesale Trade	2.6	3.0
Retail Trade	15.5	14.9

Table 2-23 (con't.)

Employment by Industry

	Non-SMSA	SMSA
Finance, Insurance and Real Estate	2.9	4.4
Services	24.0	22.4
Public Administration	3.6	4.4

Source: U.S. Census of Population, 1970.

Table 2-24

Occupational Distribution

	Non-SMSA	SMSA
Professional	9.4	13.5
Non-Farm Managers	6.7	6.5
Sales Workers	5.1	5.8
Clerical	12.4	18.3
Craftsmen	13.8	18.4
Operative	14.2	14.8
Transport Equipment	4.6	4.4
Non-Farm Laborers	4.8	4.9
Service Workers	12.4	10.8
Private Household Worker	1.8	0.8
Farm Workers	14.9	1.8

Source: U.S. Census of Population, 1970.

2.3.4. INLAND WATERWAY SYSTEM

2.3.4.1 General.

The Mississippi River and its larger tributaries comprise a major portion of the Inland Waterway Navigation System. The Inland Waterway Navigation System is a major link in the national transportation system, serving the central United States and tying together the agricultural midwest, the industrialized west, the Great Lakes, and the Gulf Coast Region via the Intracoastal Waterway System. Navigation on the Mississippi River system serves ports along the Mississippi River from the Gulf to St. Paul, Minnesota; on the Arkansas River up to Tulsa, Oklahoma; on the Ohio River up to Pittsburgh, Pennsylvania; on the Missouri River up to Sioux City, Iowa; and on the Illinois River up to Chicago, Illinois, and Lake Michigan. Additional tributaries on the Mississippi and Ohio Rivers provide numerous navigation routes. Table 2-25 shows tonnages carried on the Mississippi River System have increased substantially. High bulk cargoes having low unit values make up the vast majority of materials shipped on the waterway and include such commodities as grain, coal, petroleum, industrial chemicals, construction materials, and iron and scrap steel. Commodities movements follow predictable paths to and from major origin-destination (O-D) locations. Grain, for example, is principally shipped from areas along the Upper Mississippi and Illinois Rivers to New Orleans for processing or shipment overseas. Industrial chemicals originate in locations in the south and are shipped to processing locations along the Upper Illinois River. Coal and steel are moved down the Ohio to locations along the Mississippi River.

Table 2-25

Mississippi River System, Waterborne Tonnages

Year	Total Tonnage
1960	233,959,481
1965	301,780,091
1970	391,112,726
1972	419,805,850

Source: Waterborne Commerce of the United States; Corps of Engineers, Lower Mississippi Valley Division, Vicksburg, Mississippi, 1972.

The Inland Waterway is thus a system of interrelated parts. Each component contributes to the overall flow of traffic and in turn carries shipments originating in other locations of the system. The systemic nature of the Inland Waterway is illustrated in Figure 2-24 which shows the traffic density along the waterway in 1972. Given the nature of the interrelationship among O-D regions, changes in any one element of the system will be reflected throughout the system.

2.3.4.2 Upper Mississippi River and Illinois Waterway

The Upper Mississippi River begins at Lake Itaska, Minnesota, and extends south to the mouth of the Missouri River north of St. Louis, Missouri. The Illinois Waterway comprised of the Illinois River, the Des Plaines River, the Chicago Sanitary and Ship Canal, and the Chicago River, forms the link between the Mississippi River and the Great Lakes, and thence to the Atlantic Ocean via the St. Lawrence Seaway. As with the Inland Waterway System, as a whole this component has experienced substantial tonnage increases over the past years (Table 2-25). Principal commodities shipped on this portion of the waterway include grain, coal, petroleum, and industrial chemicals.

In the reach of the Upper Mississippi and Illinois Rivers defined as the project area most of the waterborne traffic is "through traffic" that is traffic whose origin or destination lies outside the project area. Origin or destination locations in the project area include the communities of Alton and Meredosia, Illinois, and Louisiana, Missouri. These communities accounted for the major portion of tonnages in the project area. The major commodity being shipped was grain, while multiple commodities being received are industrial chemicals, coal, petroleum, and grain.

2.4. EXISTING LAND USE

2.4.1 INTRODUCTION

Land use along the Upper Mississippi River, i.e., Pools 24, 25, and 26, is comprised of widely varied activities. Major activities on the alluvial plain and bordering uplands include public land, forest, wetlands, agriculture, free standing residential, free standing commercial/industrial, transportation, extractive, and combined urban. From the detailed land use information presented on Plate 6 A-D, general patterns are perceivable.

2.4.2 GENERAL PATTERNS OF LAND USE

Over one-half of the land in the study area is devoted to agriculture. This proportion roughly holds for the entire stretch of the Upper Mississippi River, from the head of navigation to St. Louis. Along Pools 24, 25, and 26, agriculture is

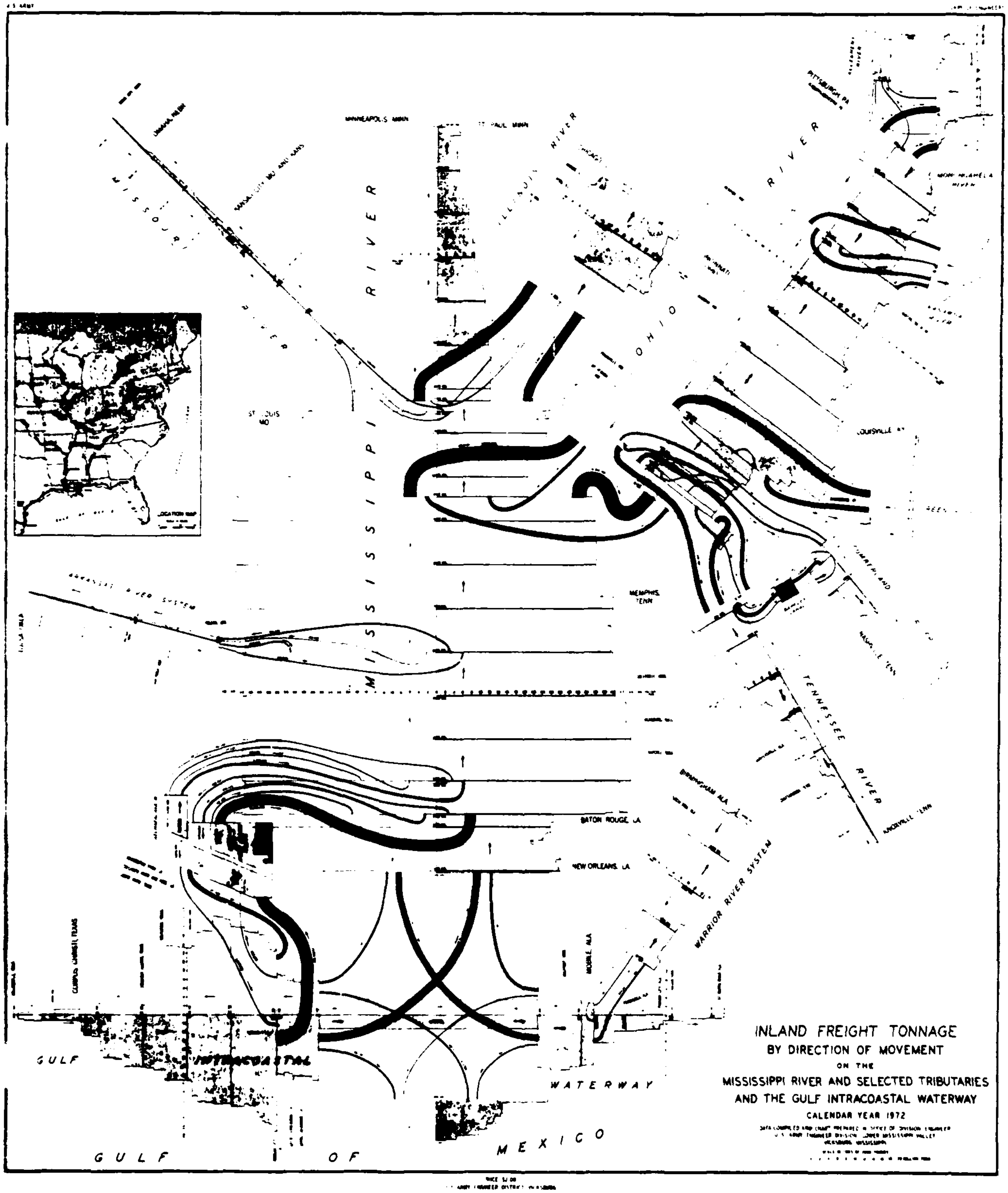

INLAND FREIGHT TONNAGE
BY DIRECTION OF MOVEMENT
ON THE
MISSISSIPPI RIVER AND SELECTED TRIBUTARIES
AND THE GULF INTRACOASTAL WATERWAY
CALENDAR YEAR 1972
MISSISSIPPI RIVER
OHIO RIVER
TENNESSEE RIVER
WARRIOR RIVER SYSTEM
ARKANSAS RIVER SYSTEM
GULF INTRACOASTAL WATERWAY
GULF OF MEXICO
MINNEAPOLIS MINN
ST. LOUIS MO
LOUISVILLE KY
MEMPHIS TENN
BIRMINGHAM ALA
BATON ROUGE LA
NEW ORLEANS LA
MOBILE ALA
CORPUS CHRISTI TEXAS
LOCATION MAP

Figure 2-24

found on the neighboring uplands, the alluvial plain, and some of the larger islands, particularly those with road or dike access. Yet, while agriculture seemingly is one of the more primal activities, as compared to urban, it has caused substantial alteration of the natural environment. Steep slopes are grazed or plowed, contributing to the erosion of the land. On the alluvial plain, agriculture has displaced large areas of native forest and has served as an impetus for the construction of extensive levee and drainage systems.

Forest is defined as areas covered by trees, but not in agricultural use. Forest is the second ranking land use and is generally found where agriculture does not take place due to physical restrictions. Thus, forest will occur in linear fashion along streams, banks of the River, ditches, steep upland valley walls, in small scattered clumps around lakes or in large bodies in natural low areas on the alluvial plain.

Public open land refers both to ownership and land use. This category refers to all large plots of land owned and/or administered by either state or federal government. This public land is primarily confined to low areas on the alluvial plain, adjacent to the River, and some of the islands in the River. Most of the public land is managed as refuges by either the U.S. Bureau of Sport Fisheries and Wildlife, the Illinois Department of Conservation, or the Missouri Department of Conservation.

Wetlands and lakes are frequent in the study area, especially on the alluvial plain, but still account for only a small portion of the area's land use. Wetlands are areas which have intermittent water, occurring in low areas, near lakes and the River. Lakes have water year-round and are usually remnants of a former river channel.

Urban development is the most conspicuous land use in the study area. Yet, the total area of development is far less than that of agriculture or forest. Except for Alton, Illinois, the urban developments are moderate in terms of the extent of physical development and offer central place functions normal of inland central places (i.e., farming communities). With only a few exceptions, the towns are regularly spaced along the river and are located on the transition zone of upland-alluvial fan-alluvial plain. Undoubtedly, the settlements began on the upland or alluvial fan, above flood stage, but later extended down onto the alluvial plain, exposing themselves to flood threats. Scattered free standing residential occurs along the River, but not of significant magnitude to map, being mostly farmsteads

or small developments. The same is true of the magnitude free-standing commercial/industrial.

Transportation facilities not only comprise a major use of land, but also more importantly add to the character and development of the land by way of relative accessibility. The Upper Mississippi River area possesses good inter- and intra-regional accessibility of highway, rail, and water. All three modes of transportation run north-south through the area and rail and highway provide east-west accessibility. (Plate 7)

2.4.3 DETAILED LAND USE

(1) Pool 24. Pool 24 begins at Clarksville, Missouri, and proceeds in a northwesterly direction for 28 river miles, terminating at Saverton, Missouri (Plate 6-C). The river width varies greatly in Pool 24, reaching a maximum width of approximately one and one-half miles near Pharris Island and having a minimum width of approximately one-half mile at Louisiana, Missouri. The alluvial plain is wider than that up river, measuring its maximum width at the Salt River tributary, almost seven miles. The average width of the alluvial plain is about five miles in Pool 24. The river in this pool is skewed toward the west bluff, leaving the eastern side of the plain for agriculture and minor urban development. The entire eastern half of the alluvial floodplain is protected by levees. The widest floodplain on the Missouri side occurs at the mouth of the Salt River.

Land use on the alluvial plain of Pool 24 is dominated by agriculture, which takes up approximately 70 percent of the area. The majority of the agriculture is cropland, but some pasture or grassland exists. Agriculture is found on several of the islands which have dikes extending to them. On the floodplain, agriculture is removed from the River located on generally higher ground. Agriculture probably could not exist at its present magnitude without the flood protection afforded by the levees.

Forest is a second major land use and represents the more natural state of the floodplain. Forest seemingly has been relegated to low areas and areas susceptible to flooding. Forest occurs on many of the islands, along the river banks, around lakes, and along streams. The largest forest area is found on the southern half of the oval-shaped bottoms at the mouth of the Salt River. Lakes and wetlands are widely scattered on the floodplain in Pool 24. Lakes include the permanent water bodies that may be open, have restricted exits, or be land locked. Lakes frequently occur along the base of the levees on the

riverward side. These lakes have formed in borrow pits resulting from levee construction. Others occupy abandoned river meanders and side channels. Wetlands are low areas where water ponds on a seasonal basis. Wetlands are more frequent than lakes, but occur in close correspondence to lakes and forest.

Public open land is another major land use in Pool 24. The Bureau of Sport Fisheries and Wildlife operates two areas, the Del Aire Division of the Mark Twain National Wildlife Refuge and the Clarence Cannon National Wildlife Refuge, on off project lands adjacent to this pool. The Ted Shanks Memorial Wildlife Area, administered by the Missouri Department of Conservation is on this pool. This unitized area comprises over 7,000 acres of lands and waters managed for fish and wildlife purposes. Over 8,000 acres of project land and water area acquired for the nine-foot navigation project are managed by the States of Illinois and Missouri for fish and game purposes under the General Plan and Cooperative Agreement. There are a number of developed public access areas along this pool developed and operated by joint agreement between the Corps and the States of Illinois and Missouri.

Urban land use on the Pool 24 floodplain consists of relatively small farming communities. The settlements occur at regular intervals at the base of the uplands. The communities are Louisiana and Ashburn, Missouri, and Pleasant Hill, Rockport, New Canton, and Kinderhook, Illinois. The Missouri towns are located on the banks of the River while the Illinois towns are several miles removed. Of the towns in Pool 24, Louisiana is the largest, having a 1970 population of 4,533.

Rail lines parallel the entire length of Pool 24 on both sides, as do highways. All towns are served by both rail and highways. A highway bridge crosses the River at Louisiana, Missouri.

(2) Pool 25. Pool 25 begins at Cap au Gris, Missouri, and extends northward 32 miles to Clarksville, Missouri (Plate 6-B). The Mississippi River travels along the eastern bluff of the floodplain from Cap au Gris to about two miles south of Bellview, Illinois, where it wanders into the middle of the alluvial plain and remains there until touching the western bluff at Clarksville. The river in Pool 25 is braided with numerous islands and varies in width from 1-1/2 miles to 1/2 mile. Going northward from Lock and Dam No. 25, the floodplain, measured bluff to bluff, gradually widens from a width of 3-1/2 miles to five miles at Clarksville. The western portion of the floodplain is the widest side in Pool 25. This side of the floodplain is leveed almost its entire length. The eastern side of the alluvial plain is narrow and only the northern half is leveed.

Land use on the floodplain of Pool 25 is about 60 percent agriculture and about 40 percent forest. Agricultural activity on the floodplain is made up almost entirely of cropland, although a small amount of grazing does exist. The broad west side of the floodplain is leveed its entire length and holds the bulk of Pool 25's agriculture. Large areas of this protected bottomland are cleared and the streams channelized. A relatively small amount of agriculture is found on the narrow eastern floodplain.

Forest occurs along the riverbanks, on the numerous islands, along streams and river side channels, and around lakes. Large areas of forest occur on the eastern floodplain, particularly that which is directly across from Foley, Missouri. Here, the land is low and wet and of limited agricultural capacity. The riverbanks are forested for nearly the entire length of Pool 25.

There are few lakes and wetlands in Pool 25. These contribute little to the overall land use of the area.

There are over 8,500 acres of project land and water administered by the Bureau of Sport Fisheries and Wildlife in cooperation with the States of Illinois and Missouri for fish and wildlife purposes. This includes the over 2,100 acre Batchtown Division of the Mark Twain National Wildlife Refuge. These areas were transferred to these agencies for fish and game management purposes under the General Plan and Cooperative Agreement for this project. In addition there are a number of developed public access areas leased to the States of Illinois and Missouri on project lands.

Urban development consists of the farming communities of Winfield, Foley, Elsberry, and Annada, Missouri; Bellview, Illinois; and Clarksville, Missouri. Elsberry is the largest community in Pool 25, having a 1970 population of 1,398.

A rail line parallels the river along the foot of the western bluff. Highways border the river on both sides.

(3) Pool 26. Pool 26 begins at Alton, Illinois, and stretches in a due west direction to Winfield, Missouri (Plate 6-A). The pool proper is widest at Lock and Dam No. 26, where it is just over one mile wide between vegetated banks. This breadth is due to the joining of the Illinois River at Grafton, Illinois. Pool 26 is its narrowest in the southern extreme, measuring about one-half mile across. The floodplain is relatively narrow at Lock and Dam No. 25, measuring about 3-1/2 miles across. It then begins to widen, being 5-1/2 miles at O'Fallon, Missouri, and increases quickly with the joining of the Illinois

and Missouri Rivers' floodplains. This wide floodplain measures over twelve miles across from bluff to bluff, and is wholly located on the west side.

Land use on the alluvial plain of Pool 26 is predominantly agriculture, which takes up approximately 60 percent of the area. Nearly all of the agriculture is cropland, with only a small amount in pasture. Unlike Pools 24 and 25, Pool 26 does not have any apparent agriculture on the islands. On the floodplain, agriculture is removed from the River, usually buffered by a corridor of forest. Agriculture on the floodplain exists without benefit of any major levees.

Forest is a second major land use on the floodplain. It is found along the riverbanks, on the islands, along streams, around lakes, and in low areas. In general, forest exists in areas where it is too wet to farm.

Lakes and wetlands on the floodplain are relatively rare in this stretch of the Mississippi River. Two large lakes occur away from the River, both near O'Fallon, Missouri. Wetlands are seasonal and occur along the river, near the two large lakes mentioned, and on several of the larger islands.

Located on this pool and above the lower 15 miles of the Illinois River, there are nearly 19,000 acres of project land and water area administrated by the Bureau of Sport Fisheries and Wildlife in conjunction with the States of Illinois and Missouri for fish and wildlife purposes. This includes the over 4,100 acres of the Calhoun unit of the Mark Twain National Wildlife Refuge. These lands were transferred to these agencies for fish and game management purposes under the General Plan and Cooperative Agreement.

Urban development in the Pool 26 floodplain is located almost entirely on the Missouri side. This development consists of the farming communities of West Alton, Portage des Sioux, Old Monroe and Winfield. On the Illinois side, the communities are located on the uplands, overlooking the River. These communities include Alton, Elsah, Chautauqua, and Grafton.

Two rail lines and several county roads parallel the pool on the west. Only one highway, Illinois Route 3, parallels the River on the east. The large plot of free standing commercial/industrial development located about two miles east of Portage Des Sioux, Missouri, is the Union Electric generating plant.

2.4.4 THE LOWER ILLINOIS RIVER, LA GRANGE TO GRAFTON, ILLINOIS

The first 80 miles of the Illinois River is influenced by Lock and Dam No. 26. This reach of river extends northward from Grafton, Illinois (river mile 0.0) to LaGrange, Illinois (river mile 80.2) (Plates 5A, B, and D). The river width, the distance between vegetated banks taken normal to the direction of flow, is narrow, averaging about one-fourth mile across. However, this is not constant, for in several places where islands exist, the river bulges to a width of three-fourth mile across. The floodplain averages just over four miles in width. Much of the floodplain is protected from overbank flow by levees. For approximately the first 15 miles, the Illinois River flows in the middle of the floodplain. The River then veers to the west, touches the western bluff at Hardin, Illinois, and flows along this bluff until reaching Valley City. At Valley City, the river takes a northeast course and again flows in the approximate center of its valley up to LaGrange.

Land use on the Illinois River floodplain is in the northern extent, past Nutwood, where agriculture appears to account for at least 80 percent of the total area. Cropland accounts for almost all of this agricultural land. In the southern extent of this reach of the Illinois River, some land that was once agricultural has been removed from the river by a wide barrier of lakes, wetlands, and forest and thus agriculture has a very small share of the floodplain. In contrast, in the northern extent, agriculture is separated from the river by only a narrow barrier of forest.

Forests and lakes account for over one-half of the floodplain area south of Nutwood. This area is naturally low and precarious to farm and thus forest has remained in large quantities. North of Nutwood, forest is found in narrow corridors along the river banks, along streams, and on the few islands. Forest in large quantities is not found again until Meredosia Lake is reached. Here again, the land is naturally low, tends to flood, and is thus risky to farm.

Lakes and wetlands, like forest, are relatively scarce on the floodplain, occurring in large areas only at Grafton and Meredosia. At these two points, lakes and wetlands are the dominant land use.

Located on the lower Illinois River, just upstream from Grafton, Illinois, is situated the 5,000 acre Pere Marquette State Park, largest state park in Illinois. There are numerous public access areas on project lands, and over thirty major boat dock and marina locations on private properties along the shoreline

of the pool. Additionally, there are a significant number of seasonal cottage sites on project lands, leased to private individuals who avail themselves to the many water oriented outdoor recreation pursuits the project offers.

Urban development along the Illinois River consists of regularly spaced and moderately sized farming communities and regional centers near the bluff as well as in the middle of the floodplain. Communities at the base of the bluffs include Grafton, Nutwood, Hardin, Spanky, Michael, Eldred, Kampsville, Bluffdale, Hillview, Pearl, Montezuma, Forence, Oxville, Valley City, Chambersburg, and LaGrange. Floodplain communities consist of East Hardin, Naples, and Meredosia. Meredosia is the largest community on this reach of the Illinois River. Three rail lines cross the floodplain. The first going from Versailles, through Meredosia, to Bluffs. The second rail line goes from Valley City, through Naples, to Bluffs. The third rail line crosses the Illinois River at Pearl going to Hillview. There is no rail line parallelling the river in this reach. However, highways do parallel and transect the river, giving this reach adequate road access.

2.5 OUTDOOR RECREATION

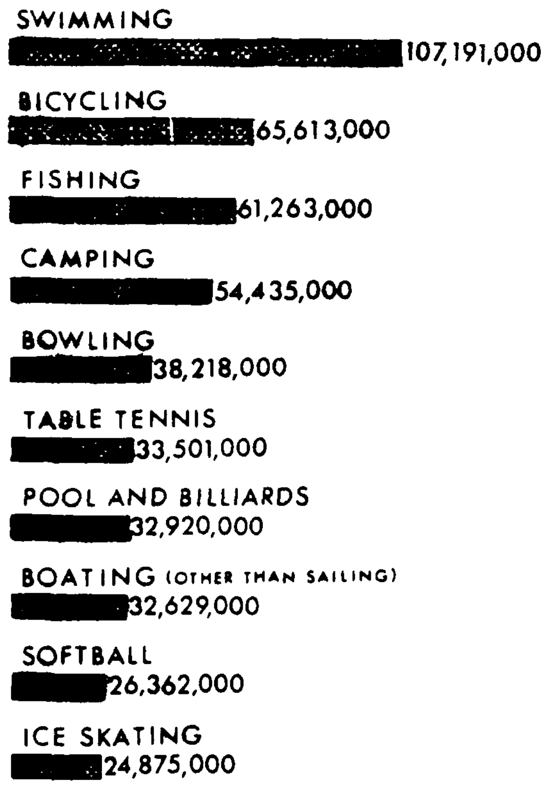
As leisure time and affluence have increased, outdoor recreation has become an increasingly important part of the lifestyle of much of the United States. Studies made in recent years have documented the growth in recreational demand, and have indicated the most popular forms of outdoor recreational activities. Figures 2-25 and 2-26 present the results of recreational demand surveys done at the national and St. Louis SMSA levels. As can be seen, popular activities in both studies include swimming, bicycling, and fishing.

In the study area, the Mississippi and Illinois Rivers are major outdoor recreation resources. The riverine landscapes consisting of high bluffs and floodplains of varying widths, afford picturesque views and provide a desireable environment for outdoor recreation. The rivers are used extensively by residents in the study area as well as by many of the two million plus residents of the St. Louis SMSA. Boating, sightseeing, and fishing rank as the three most popular recreation activities on the river (Table 2-26).

Data compiled by the Corps of Engineers on outdoor recreation usage at public access sites on the Mississippi and Illinois Rivers illustrate the importance of these rivers as recreation resources. On the Mississippi River in the study area there are 25 public access areas operated by the Corps of Engineers,

FAVORITE AMERICAN SPORTS

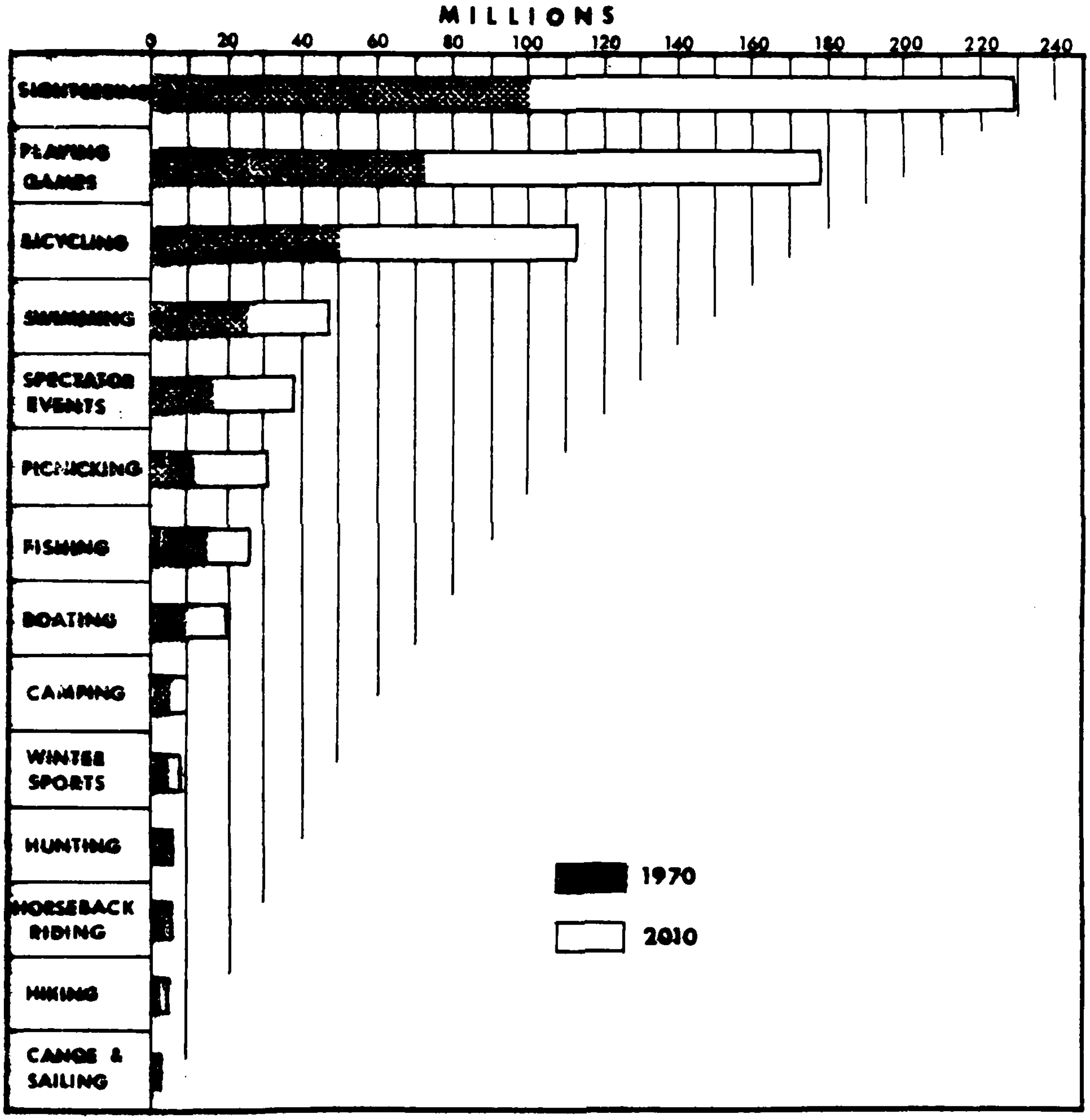
ESTIMATED NUMBER OF PARTICIPANTS BY SPORT



SOURCE: A.C. NIELSEN CO.

Figure 2-25

ESTIMATED ANNUAL RECREATION PARTICIPATIONS
ST. LOUIS REGION



ESTIMATES BASED UPON A SURVEY OF MISSOURI OUTDOOR RECREATION PLAN

SOURCE: Harland, Bartholomew & Associates

Figure 2-26

the State of Missouri, State of Illinois, or private concessioners. In 1972 these sites received 3,993,600 recreation days of attendance. The Illinois River also receives substantial recreation use. In the study area the 12 public access sites on which the Corps of Engineers maintains user statistics received 89,400 visitor-days attendance in 1972.

Table 2-26

Public Access Area, Activity Use

Activity	Percent Participating in Activity*
Sightseeing	73.2
Boating	71.6
Fishing	32.2
Swimming	26.5
Picnicking	23.4
Water-skiing	22.9
Camping	5.0
Other	17.3

*Note: Percentages do not total 100 because of duplication of activities; e.g., many individuals come to a facility to fish and picnic, etc.

Source: 1972 Annual Report, Recreation-Resource Management System, Corps of Engineers

2.6 CULTURAL RESOURCES

2.6.1 ARCHAEOLOGY

The valleys of the Mississippi and Illinois Rivers constitute two of the richest locations for the study of prehistoric man's cultural patterns in the United States. Man's presence has been ascertained in these valleys for at least 10,000 years, and the number and diversity of sites from different periods of aboriginal development make these areas especially significant.

In the Illinois and Mississippi Rivers' floodplains located within the study area boundaries, the locations of several hundred archaeological sites have been recorded with the Illinois Archaeological Survey and the Missouri Archaeological Survey. Most of the known sites have been located along the alluvial terraces of the floodplain or at locations away from the shoreline of cities on the Mississippi or Illinois Rivers. As has been noted however, little systematic investigation of the shorelines has been performed by archaeologists (Denny, 1975).

Detailed information on shoreline site locations is important along the Illinois River because dredge materials are deposited on or along the shoreline. A comprehensive archaeological investigation is therefore currently underway along the entire 80 mile reach of the Illinois River in the St. Louis District. Sites capable of being adversely affected by deposition of dredged materials are being enumerated. This investigation will be completed before the next dredging season and will be used in the planning of disposal sites.

No such investigations are being planned for the shoreline of the Mississippi River. Under current practices dredged materials from the navigation channel are deposited back into the river with no impact on the shoreline. The construction of bankline revetments or dikes involves disruption of small portions of shoreline.

2.6.2 HISTORY

A total of 16 historic properties on the National Register of Historic places are located in the counties adjacent to the Mississippi and Illinois Rivers in the study area. None of these properties are located where they are capable of being impacted by Operation and Maintenance activities.

PART 3

3. RELATIONSHIP OF THE ACTION TO LAND USE PLANS

3.1 PLANS OF OTHER FEDERAL AND STATE AGENCIES

Under the "General Plan and Cooperative Agreement" actions of the subject project and their relationship to plans of federal and state agencies are coordinated with the appropriate agencies, i.e., U.S. Fish and Wildlife Service, Illinois Department of Conservation, and Missouri Department of Conservation. The coordination with the plans of state and federal agencies is developed in Section 1.6 of this report. Due to the degree of coordination, the subject action is generally compatible with the land use plans and objectives of affected state and federal lands.

3.2 PLANS OF LOCAL AGENCIES

3.2.1 STATE OF PLANNING

Land use planning for the Missouri and Illinois counties along Pools 24, 25 and 26, is in a mixed state of planned and unplanned land, as well as proposed and adopted plans. Table 3-1 presents a summary of the status of land use planning in the study area. Though a number of counties have land use plans (Plate 8), only four counties have both a plan as well as planning authority. These counties are St. Charles County and Ralls County, Missouri, and Madison County and Pike County, Illinois.

3.2.2 ST. CHARLES COUNTY, MISSOURI

The Land Use Plan and Transportation for St. Charles County is detailed for only the eastern edge of the country. The plan contains a number of proposals in relation to the Mississippi River. Specifically, the shoreline along Pool 26 is designated for recreational residences (i.e., seasonal dwellings) as well as greenbelt agricultural lands, parks, and open space. Only one town, Portage des Sioux, borders the River. The town is proposed to remain low density residences (5 units per acre or less). The only proposed major development near the Mississippi River is for "major industry". This development is proposed just west of Missouri Highway 94 (See Plate 8).

3.2.3 RALLS COUNTY, MISSOURI

The Mark Twain Regional Plan containes only minor proposals for that part of Ralls County near the Mississippi River, (Plate 8). Like the remainder of the county, the majority of the area near the River is proposed to remain in agriculture. Only minor low density residential is planned to develop in the northeast corner of Ralls County along Missouri Highway 79, coming south from the city of Hannibal. No true river-oriented development is proposed for Ralls County. However, this does not preclude the possibility of its growth.

3.2.4 MADISON COUNTY, ILLINOIS

The Land Use and Transportation Plans for Madison County, Illinois, designate proposed land use for that portion of Madison County in the study area, i.e., that land along Pool 26. Most of the land is planned for the land use already existing on it. Of the land bordering the River, industry is proposed for where it exists now: on the floodplain at Alton, Illinois (Plate 8). The remainder of the floodplain at Alton is planned to remain open in character, i.e., agriculture, recreation, parks, and open space. Past Alton, the floodplain terminates and limestone bluffs appear; thus, the land adjacent to the River, really lies above it. This land is well dissected, having high local relative relief. This type of terrain extends along the River for the rest of Madison County; i.e. a narrow floodplain against high bluffs, and a well dissected upland. Due to these physical limitations, agriculture interspersed with low density residential is proposed as future land use. Several commercial docks are proposed along the River in connection with rail and major highway, Illinois Highway 3.

3.2.5 PIKE COUNTY, ILLINOIS

The Regional Development Plan, Pike County, Illinois, dated 1970, is the existing plan for the county. However, the documents potential as the proposed plan is doubted and thus, its relationship to the subject action should be qualified. Looking at the Plan (Plate 8), land adjacent to the Mississippi River is proposed to remain open, being agriculture or vacant. A Corps of Engineers access point and a marina or boat launch are proposed for land opposite of Louisiana, Missouri, north of U.S. Highway 54. Industrial development is proposed west of Pleasant Hill, Illinois, on the floodplain, but removed from the River.

The land adjacent to the Illinois River, the plan proposes the continued existence of Pearl, Florence, and Valley City, as incorporated areas and that the floodplain be preserved in an open or passive use. Two large areas adjacent to the River and north of Valley City are proposed for industry.

3.3 COMPARISON OF THE ACTION TO LAND USE PLANS

A comparison of the land use plans discussed above to the location and description of the subject action shows no direct contradictions in the future land use types or the location of a land use. This lack of impact is due to the fact that dredge material is negligible in relation to the scale of the existing plans. Additionally, several of the plans appear to have assumed not only the continued navigation is illustrated by the numerous proposed industrial developments along the River and commercial docks. The assumption of continued pool condition is shown by the proposed seasonal dwellings in the plan for St. Charles County.

Table 3-1 Summary of Status of County Land Use Planning, Pools 24, 25, and 26

	County	Existence of Plan	Status of Plan
1.	St. Charles Co., Mo.	Yes	Planning authority adopted - 1959 Most current plan - 1970
2.	Lincoln Co., Mo.	Currently being reassessed	Voted and defeated planning authority - 1974
3.	Pike Co., Mo.	Yes	No planning authority
4.	Ralls Co., Mo.	Yes	Planning authority adopted - 1964 Most current plan - 1968
5.	Madison Co., Ill.	Yes	Plan adopted - 1973
6.	Jersey Co., Ill.	No	No authority
7.	Calhoun Co., Ill.	No	No authority
8.	Pike Co., Ill	Yes	Planning authority adopted - 1974 Most current plan - 1970
9.	Brown Co., Ill.	No	Planning authority adopted - 1974
10.	Greene Co., Ill.	No	No authority
11.	Scott Co., Ill.	No	No authority
12.	Morgan Co., Ill.	No	No authority
13.	Cass Co., Ill.	No	No authority

PART 4

4. IMPACT OF THE ACTION ON THE ENVIRONMENT

4.1 PHYSICAL IMPACTS

4.1.1 IMPACT TO RIVER REGIME

4.1.1.1 Review

In Part 1, PROJECT DESCRIPTION AND HISTORY, a description of the 9-foot channel project and the operation and maintenance of the locks and dams was presented. In 2.1.2, RIVER CHANNEL CONFIGURATION, earlier attempts of river regulation were described. In summary, the River and Harbor Act of July 3, 1930 authorized the 9-foot channel project in the Upper Mississippi River. Within the study reach, work began officially on January 13, 1937 at Lock and Dam No. 26 at Alton, Illinois. First full pool was obtained in Pool 26 on August 8, 1938, in Pool 25 on July 11, 1939 and in Pool 24 on May 14, 1940. The 9-foot channel project in the study reach was placed completely in operation on March 12, 1940.

The locks and dams have changed the character of the river. The permanent change in low-flow water levels submerged the dikes constructed during the 4-½ foot and 6-foot channel projects, and no longer can Sunday excursionists walk across the river at low water. In addition, the creation of the pools and a stable low-water level was a boon to wildlife (Gabrielson, 1937).

4.1.1.2 Short Term Geomorphic Response

In the fall of 1939, the first continuous hydrographic survey of the study reach of the Mississippi River since the closure of the three dams was made. This survey provides a picture of the immediate response of the river to the river closure caused by the dams.

In 1939, the surface area of the river had not yet changed in response to the closure of Dams 24, 25, and 26. More time was required to convert land vegetation submerged by the closures into water and water vegetation. In fact, during the first two winters after closure of the dams, the areas flooded by the pools were logged of timber.

The closures of Dams 25 and 26 had not yet affected the size and number of islands but, for the record, the number of islands in the study reach are given in Table 4-1. The great increase in the number of islands in Pool 24 was due probably to the degradation in Pool 24 that in turn resulted from the sequence of construction (see Riverbed Elevations in 1939). Also the 1930's were dry years so the low water levels caused by droughts and degradation would allow the land vegetation to take hold on exposed sandbars.

Table 4-1

Number of Islands, 1929 and 1939

Location	Number of Islands		
	1929	1939	Change
Pool 26:			
Below Illinois confluence	-	11	-
Middle third	23	21	+ 2
Upper quarter	11	11	0
Pool 25:			
Lower quarter	13	17	+ 4
Middle half	28	32	+ 4
Upper quarter	24	16	- 8
Pool 24:			
Lower quarter	13	19	+ 6
Middle half	29	57	+ 28
Upper quarter	9	20	+ 11

The 1939 average riverbed elevations in deepest 1000 feet of the Mississippi River channel in the study reach are given in Table 4-2. For comparison, the change in riverbed elevations between 1929 and 1939 are also presented.

Table 4-2

Average Riverbed Elevations in the 1939 Upper Mississippi River

Location	Average Riverbed Elevation,* ft Amsl	
	1939	Change since 1929
Pool 26:		
Below Illinois River	390.2	-
Middle third	400.7	- 0.8
Upper quarter	405.7	+0.5
Pool 25:		
Lower quarter	410.9	+0.8
Middle half	414.5	-2.6
Upper quarter	421.5	-2.0
Pool 24:		
Lower quarter	424.7	-2.1
Middle half	427.2	-3.3
Upper quarter	430.8	-5.8

*Average of the riverbed elevations in the deepest 1000-feet width of river channel.

The immediate response of the river channel bed in the study reach to the construction of locks and dams in and upstream of the study reach was, in general, to degrade. For the study reach as a whole, the riverbed in the deep part of the channel went down approximately 2.0 feet between 1929 and 1939. Only the upper quarter of Pool 26 and the lower quarter of Pool 25 had aggradation.

By stopping the normal movement of sediments in the pools upstream of Pools 24, 25 and 26, general degradation occurred. The variation in degradation throughout the study reach was probably due in part to the sequence in which the locks and dams were constructed. The larger amount of degradation in the Pool 24 reach could be the result of the fact that Lock and Dam 22 immediately upstream was completed two years before Lock and Dam 24 and one year before Lock and Dam 25.

4.1.1.3 Long Term Geomorphic Responses

During 1973, the U.S. Army Corps of Engineers obtained color-infrared aerial photographs of the study reach of the Upper Mississippi River. These photographs and the 1971 hydrographic survey data were used to assess the long-term response of the river to navigation development with Locks and Dams 24, 25 and 26. The man-induced geomorphic features shown in the photographs have developed over a 33-year period of lock and dam operations.

An uncontrolled mosaic of Pool 25 was prepared from the 9 inch x 9 inch color prints of the 1973 aerial photographs. From a copy of this mosaic shown in Figure 4-1, the surface areas of Pool 25 were measured. The surface areas are given in Table 4-3.

Overall, between 1929 and 1973 the surface area of the river in the Pool 25 reach increased 3.4 square miles or 11 percent. The increase was due primarily to the submergence of floodplain areas immediately upstream of Lock and Dam 25. There were no appreciable changes in the surface areas of the middle half and upper quarter of Pool 25.

In 1973 there were 92 islands in Pool 25 having a total area of 10.36 square miles. This is an increase of 27 islands since 1929. The increase in area was 3.9 percent. Most of the new islands were in the lower quarter of the pool. These islands were created by submerging low areas on the floodplain and on larger islands to form new chutes. For example Maple Island came back into existence again due to the submergence of the former side channel resulting from the operation of Lock and Dam 25. This island had become joined to the Illinois mainland between 1891 and 1929.

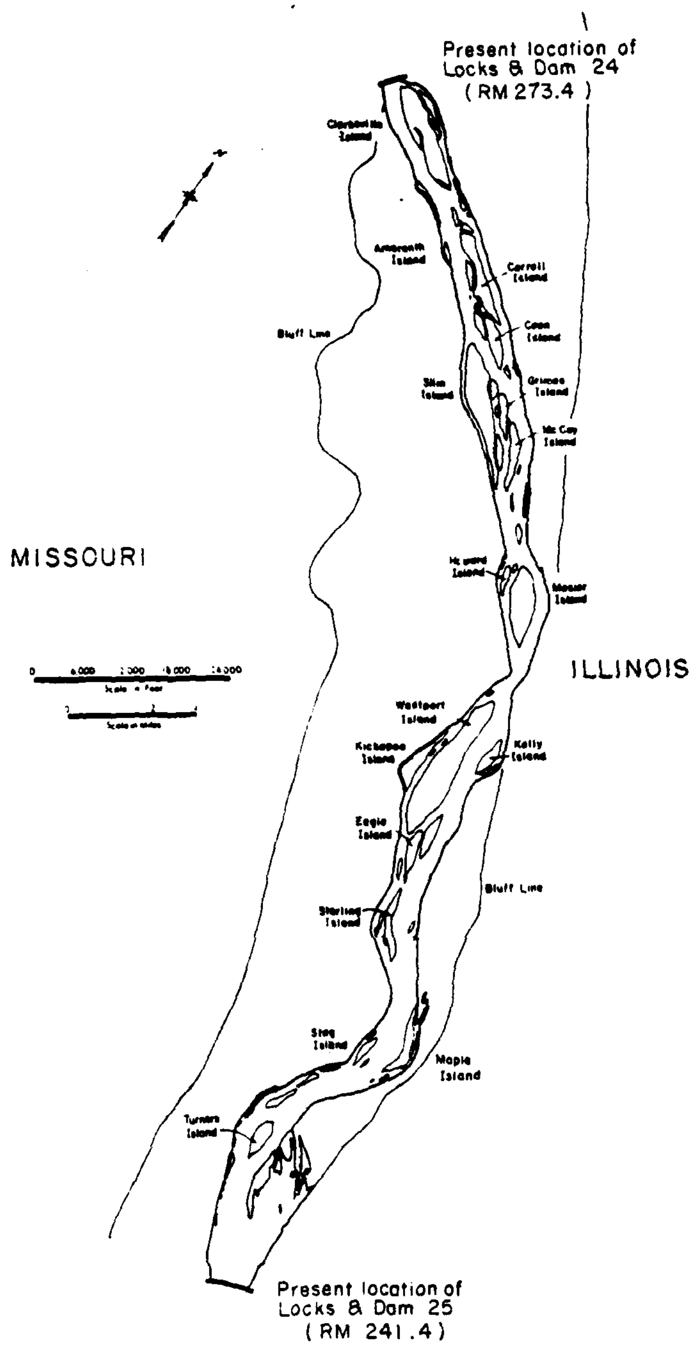


Figure 4-1 Map of the Pool 25 reach of the Mississippi River in 1973

Table 4-3

Surface Area of Pool 25 in 1973

Location	Surface area, sq mi		
	River	Islands	Riverbed
Pool 25:			
Lower quarter	10.200	1.703	8.497
Middle half	14.972	4.816	10.156
Upper quarter	7.750	3.841	3.909
	32.922	10.360	22.562

Many of the former islands in the lower quarter of Pool 25 were lost by the construction of Lock and Dam 25. Sandy Island became attached to the Missouri floodplain during the construction period. Sarah Ann Island and its three neighbors became submerged.

As shown in Table 4-4, the islands in the lower part of the pools decreased in size and the islands in the upper parts grew in the period between 1929 and 1973. The two situations are illustrated in Figures 4-2, 4-3.

Table 4-4

Changes in surface areas of Islands from 1929 to 1973

Name	Approx. River Mile	Surface area, sq mi	
		1973	Change since 1929
Pool 26:			
Piasa	209	.236	-
Mason	220	.442	-.012
Sweden	234	.113	+.062
Peruque	234	.525	+.035
Cuivre	236	2.305	+.145
Pool 25:			
Turners	245	.230	-.140
Mosier	260	.722	+.068
Coon	267	.296	+.043
Carroll	268	.568	+.129
Clarksville	272	1.051	+.152
Pool 24:			
Crider	279	.093	-.051
Unnamed	280	.097	-.034

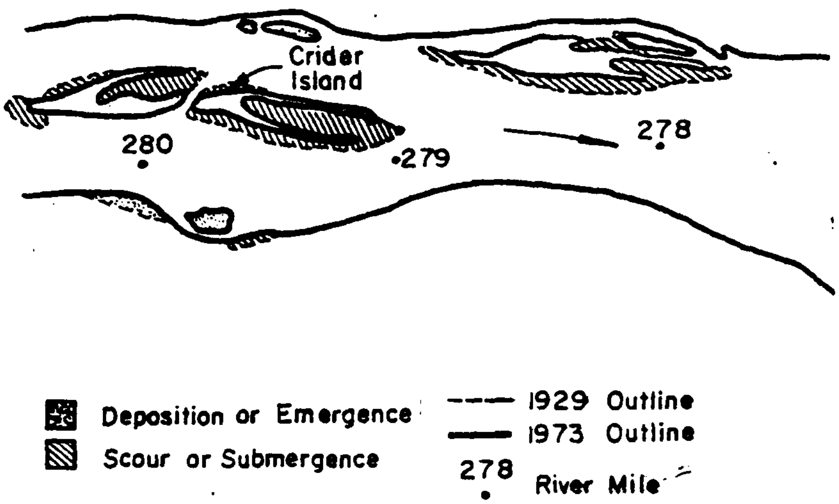


Figure 4-2 Decrease in size of Crider Island between 1929 and 1973

In Figure 4-2 the outlines of Crider Island and the unnamed island immediately upstream are shown for 1929 and 1973. These islands are in the lower quarter of Pool 24 and immediately upstream of Lock and Dam 24. These two islands are good examples of the decreases of island area and the formation of a "crab-claw" outline of some islands.

The Clarksville Island reach immediately below Lock and Dam 24 is shown in Figure 4-3. Between 1929 and 1973 there was a significant enlargement of Clarksville Island. Also, new islands have formed and some chutes have been abandoned.

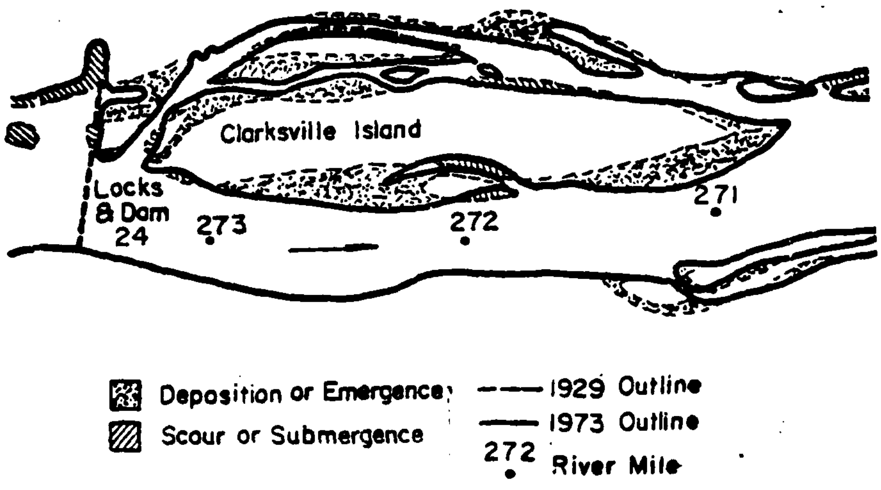


Figure 4-3 Growth of Clarksville Island between 1929 and 1973

The abandonment of agricultural lands on some islands between 1929 and 1973 was also noted. As water levels rose behind the locks and dams, the fields on the islands were submerged.

The riverbed areas in Pool 25 were measured on the 1973 mosaic and are given in Table 4-3. The growth in number and size of the islands in Pool 25 between 1929 and 1973 was more than offset by the submergence of parts of the floodplain so the riverbed area in Pool 25 increased only slightly due to the operation of Lock and Dam 25.

The average surface widths in Pool 25 in 1973 were measured on Figure 4-1 and are given in Table 4-5. The average surface width of the Mississippi River in Pool 25 was 5610 feet, an increase of 580 feet since 1929. Almost all of the river widening between 1929 and 1973 was due to the submergence of the Illinois floodplain in the lower quarter of Pool 25 immediately above Lock and Dam 25.

Table 4-5

Average River Surface Widths in Pool 25 of the Upper Mississippi River in 1973

Location	Surface Width ft
Pool 25:	
Lower quarter	6950
Middle half	5100
Upper quarter	5280

The 1971 average riverbed elevations in the deepest 1000 feet of the Mississippi River channel in the study reach are given in Table 4-6.

Table 4-6

Average Riverbed Elevations in the Mississippi River in 1971

Location	Average Riverbed Elevation,* ft Amsl		
	1971	Change since 1939	Change since 1929
Pool 26:			
Below Illinois River	389.0	-0.4	-
Middle third	400.8	+0.1	-0.7
Upper quarter	402.4	-3.3	-2.8
Pool 25:			
Lower quarter	408.2	-2.7	-1.9
Middle half	415.4	+0.9	-1.7
Upper quarter	419.0	-2.5	-4.5
Pool 24:			
Lower quarter	427.4	+2.7	+0.8
Middle half	429.2	+2.0	-1.3
Upper quarter	432.7	+1.9	-3.9

*Average of the riverbed elevations in the deepest 1000-feet width of river channel.

The long-term response (to 1973) of the riverbed in Pools 24, 25 and 26 to the construction and operation of the locks and dams in the Upper Mississippi River has been degradation. The amount of degradation is determined by comparing the 1929 riverbed elevations (before locks and dams) to the 1971 elevations. These values are given in Table 4-6.

Between 1939 and 1971, the riverbed in the deep part of the channel in Pool 24 aggraded approximately 2.0 but the two downstream pools degraded on the average. After the initial bed lowering between 1929 and 1939, Pool 24 has been filling slowly. Pools 25 and 26 may still be degrading slightly.

With the creation of new islands resulting from the construction and operation of Locks and Dams 24, 25 and 26, many new side channels were formed between 1929 and 1973. The 1973 chutes in Pool 25 are shown in Figure 4-1. However some chutes were filled up during the same period. For example, Sandy Chute that had been in existence for more than a century was lost due to the construction of Lock and Dam 25.

The other two long chutes in Pool 25 have survived. In 1973, Westport Chute remained approximately 830 feet wide and 3.9 miles long (the same as in 1929). Slim Chute lengthened slightly between 1929 and 1973 but remained the same width.

The closure of side channels in the study reach of the Mississippi River is apparently a slow process and is almost negligible on the Illinois River. From the data available for this study it was apparent that some of the old dikes have accelerated the closure of some side channels and have not affected others.

The levee system shown in the 1972 Upper Mississippi River Navigation Charts is essentially the same as the 1929 system. The Illinois and Missouri floodplains are protected adjacent to Pools 24 and 25 and the Illinois River floodplain is also protected. However, the Missouri floodplain between the Upper Mississippi and Missouri Rivers is not protected. In fact, overbank flows from the Missouri River cross the floodplain into Pool 26 and are measured as Upper Mississippi River flows at the Alton gage.

The effect of the levees in the study reach of the Upper Mississippi River on flood peaks of a yearly hydrograph has been calculated. For a peak inflow of 227,000 cfs (which is a low hydrograph) into the reach and a 40-day long flood, the flood stage level would be approximately 0.1 feet lower without the levees. The effect of the levees is less for longer peaks. It is concluded that the levees have no appreciable influence on the flood peaks in the study reach. (Simons et. al.).

Except in the floodplain region between the Upper Mississippi and Missouri Rivers, the floodplains in the study reach are protected from flooding by levees.

During the last 100 years, agricultural development on the floodplains of both Mississippi and Illinois Rivers has been extensive. Tributary streams have been channelized between the bluff line and the major rivers. To a large extent the normal floodplain morphology has been obliterated by leveling and cultivation. In short, the floodplains have been extensively developed and modified, while the river control effort was underway.

These two very different development schemes undoubtedly influence one another. Channelization of tributaries and upland agricultural activities deliver more sediment to the major rivers, which, because of their development, may or may not be competent to move the sediment out of the area. For example, sediment delivered to a backwater area is probably deposited permanently.

There is, of course, a natural rate of deposition adjacent to the main channel. Although no field information on this topic is available for the study area, a recent study carried out after the 1973 flood in the state of Louisiana showed that average sediment deposits were 21 inches along the natural levees and 0.4 inches in backswamp areas (Kesel et al., 1974).

The increased depth of water behind the dams provides deposition in tributary channels. It is not possible to separate the effect of the higher water levels on the Mississippi and that of upland agricultural activities; nevertheless, according to measurements made at bridges over Piasa, Elsah and Chautauqua Creeks in Illinois, there has been a net deposition in the tributary channels since the bridges were constructed. The channel bed level in Piasa Creek, about 1500 feet from the Mississippi channel, was 2.5 feet higher in 1974 than in 1956. In Elsah Creek, about 100 feet from the Mississippi, the bed was 2 to 4 feet higher in 1974 than in 1961. In addition, the state highway departments frequently clear sediment from the channels tributary to both the Mississippi and Illinois Rivers.

The town of Grafton, Illinois, located at the junction of the Illinois and Mississippi Rivers and about 16 miles upstream from Lock and Dam 26, has been troubled in recent years by deposition in five small tributary streams. Sediment was cleared from these streams in 1970, but it was necessary to clean them again in 1974 when about 5000 cubic feet of sediment was removed from 680 linear feet of channel. This corresponds to approximately 12 cubic feet of sediment per linear foot of channel.

The tributaries show evidence of aggradation but not all of this can be attributed to the higher water levels created by the locks and dams. Channelization and increased agricultural and urban activity are also factors.

The surface areas of the Lower Illinois River in 1939 and in 1956 are given in Table 4-7. In general these values show a negligible change in island and river surface areas between these dates. In the Lower Illinois River upstream of Swan Lake, the channel has undergone only minor changes in area. The major islands have not changed and no new islands have appeared.

The width of the Lower Illinois River has remained remarkably stable except near its junction with the Mississippi River as shown in Table 4-8. The width in this area was approximately 1100 feet in 1878 but was increased greatly when the major inundation of the floodplain in the Swan Lake area occurred following closure of Lock and Dam 26. For about nine miles above the junction, the backwater from Lock and Dam 26 has increased the width of the Illinois River from approximately 1000 feet to a maximum of 6000 feet. Farther upstream the width is nearly constant.

The sand carrying capacity of the upper three-quarters of Pool 25 in 1973 has been estimated. Assuming that the gates at the dams are open all year, the estimated rate is 3,200,000 tons/yr, an increase of 3 percent over the capacity estimated for the same reach in 1929. Under normal pool regulation, the sediment transport rate is about 70 percent of this estimated value. The average riverbed width in the upper three-quarters of Pool 25 in 1973 was 3200 ft.

The pronounced degradation and a large increase in the number of islands in Pool 24 were the most noticeable immediate responses of the Upper Mississippi River to the construction of Locks and Dams 24,25, and 26 and other dams upstream.

After 32 years of operation, the riverbed in Pool 24 had aggraded slightly but was not yet to its level prior to the construction of Locks and Dams 22 and 24. In Pools 25 and 26, the average riverbed levels in 1971 were lower than in 1929.

In Pool 25, submergence of part of the Illinois floodplain, caused by the closure of Locks and Dam 25, resulted in an 11 percent increase in surface area of the river. Overall, the surface width of this reach widened approximately 580 ft. Also, the number and surface area of islands in Pool 25 increased. Those in the lower end of the pool decreased in size and those in the upper end enlarged. The computed sand transport capacity of the 1973 river in Pool 25, assuming that the gates at the dams were open all year, was approximately 3,200,000 tons/yr, a slight increase since 1929. Under normal pool regulation the sediment transport rate is about 70 percent of this estimated value.

There are more side channels in the study reach of the Upper Mississippi River after 34 years of lock and dam operation than there were prior to dam construction. The long chutes in Pool 25 have hardly changed in this 34-year period.

The levees in the study reach have had no appreciable effect on the flood peaks in the reach. However, many of the tributaries on the floodplain have aggraded due to the higher low-flow stages in the pools.

Table 4-7

Surface Areas of the Lower Illinois River

Location	River Miles	Year	Surface Area, sq mi Riverbed	Island	Total Surface
Swan Lake	3 to 9	1940	3.6	1.1	4.7
		1956	4.4	0.9	5.3
Apple Creek	30 to 36	1940	1.1	0.06	1.2
		1956	1.2	0.05	1.3
Little Sandy Creek	43 to 51	1939	1.1	0.1	1.2
		1956	1.0	0.2	1.2
McGhee Creek	67 to 72	1939	0.78	0.09	0.87
		1956	0.72	0.08	0.80

Table 4-8

Average River Surface Widths in the Lower Illinois River

Location	Average Width, ft 1939	1956	1973
River Mile 0 to 8	2480	2970	2100
River Mile 9 to 73	1230	1230	1200

4.1.1.4 Effect on Discharges and Stages

Locks and Dams 24, 25 and 26 have had an effect on how water and sediment move through the study reach. Moreover, upstream dams have decreased the amount of sediment coming into the study reach.

At low and intermediate flows, the pool levels are raised above the natural level by the dams. This increases the depth of flow, decreases the flow velocity and decreases the sediment movement. Thus, flow velocities and sediment transport at low and intermediate flows are less with pools than in the natural river.

At low and intermediate flows, the velocity in the upper end of a pool is generally greater than in the lower end. As the sediment transport rate is largely dependent on the flow velocity, the sediment transport rate at the upper end of the pool is greater than at the lower end and is also greater than the supply rate from the pool immediately upstream. The result is that erosion occurs in the upper reach of the pool and deposition occurs in the lower reach.

At high flows, the gates are opened above the water level and flow conditions approach the natural river state. During floods, deposition occurs in the portion of the river that was eroded at low flow (the upper end of the pool) and erosion occurs in the portion of the river that was aggraded at low flow (the lower end of the pool). This erosion and deposition due to the locks and dams is repeated on a yearly cycle.

The river crossing areas in a pool accumulate a slightly larger amount of sediment during the deposition part of the cycle than during the erosion part. Conversely, the deep areas in the river tend to deepen. Thus, over a long period of time, the shallow areas aggrade slightly and the deep areas in the river channel deepen slightly.

The effects of the locks and dams on the geomorphology of the rivers are reflected in the river gage records in the study reach. The study area is bracketed by three gaging stations with relatively long-term discharge and stage records. The Alton, Illinois station on the Mississippi River immediately below Lock and Dam 26 has reported discharges and stages intermittently from 1844 to 1896 and then continuously to the present. Immediately below Lock and Dam 19 at Keokuk, Iowa on the Mississippi River (65 river miles above the study area), the discharge record is discontinuous from 1851 to 1880 and continuous thereafter; while maximum and minimum stages have been reported intermittently from 1851 to 1870 and then continuously to the present. The Meredosia, Illinois station (published as "at Beardstown" prior to 1939) has continuous discharge data since 1921, as well as intermittent stage data from 1844 to 1879 and continuous stage data thereafter. In addition, the Corps of Engineers has compiled stage records at Hannibal, Missouri, nine river miles above Lock and Dam 22; and at Grafton, Illinois; at the confluence of the Mississippi and Illinois Rivers.

The River Mile locations of the gages and other important features are given in Table 4-9.

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OPERATION AND MAINTENANCE POOLS 24, 25, AND 26 MISSISSIPPI AND --ETC(U)
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Table 4-9

Locations of Selected Features in the Study Reach

Feature	River Mile	Remarks
	Locks and Dams	
Lock and Dam 26	202.9	At Alton, Illinois
Lock and Dam 25	241.4	At Cap Au Gris
Lock and Dam 24	273.4	At Clarksville, Missouri
Lock and Dam 22	301.2	
	Cities and Towns	
St. Louis, Missouri	179	
Alton, Illinois	203	
Grafton, Illinois	218	
Clarksville, Missouri	273	
Louisiana, Missouri	283	
Hannibal, Missouri	309	
	Gages	
Alton, Illinois	202.7	Immediately downstream of Lock and Dam 26
Grafton, Illinois	218.0	Approximately 6 mi upstream of Lock and Dam 26
Meredosia, Illinois	70.8*	Approximately 86 mi upstream of Lock and Dam 26
Hannibal, Missouri	309.0	Approximately 8 mi upstream of Lock and Dam 22
Keokuk, Iowa	364.2	Immediately downstream of Lock and Dam 19
	Confluences	
Mouth of Illinois River	218.0	In Pool 26
Mouth of Dardenne Creek	227.0	In Pool 26
Mouth of Cuivre River	236.5	In Pool 26
Mouth of Salt River	284.2	In Pool 24

*Illinois River Mile measured from the confluence of the Illinois and Mississippi Rivers.

The Alton stage gage is located downstream of Lock and Dam 26 and is influenced by backwater from the Missouri River. Similarly, the Keokuk gage, located immediately below Lock and Dam 19, is influenced by backwater from the Des Moines River. To provide a long-term stage and discharge comparison not affected by backwater from a major tributary, discharges from Keosaugua on the Des Moines River and Keokuk on the Mississippi River were combined downstream at Hannibal, where Corps of Engineers stage data are available. The Hannibal gage is in Pool 22. The discharge at Hannibal on any given day was estimated by combining the discharge reading at Keokuk one day earlier.

The highest twenty stages at Hannibal are shown in Table 4-10. The largest ten synthesized discharges with corresponding stages are listed in Table 4-11.

Analysis of the information in Table 4-10 and 4-11 indicates that the flood stage-versus-discharge relation at Hannibal has not changed appreciably during the period of record. That is, floods produce approximately the same stages passing Hannibal today as they did before locks and dams.

On the Upper Mississippi River, the annual flood discharges gaged at Alton and Keokuk have remained on the average unchanged in the last 110 years. The mean annual flow at Alton has been increasing slightly whereas it has been decreasing slightly at Keokuk. The annual minimum discharge has been increasing at both gages.

The history of maximum, minimum and mean annual discharges on the Illinois River at Meredosia does not show any trends.

Locks and Dams 24, 25 and 26 have no appreciable effect on the amount of water moving through the study reach. The yield of runoff from the Upper Mississippi Basin has not changed appreciably in the period of record either.

At the Alton stage gage immediately below Lock and Dam 26 there is no trend in the annual maximum stage in the 100 years of record. The annual minimum stage record shows a sharp decrease in minimum stage after the mid-1930's followed by a sharp increase in minimum stage in 1960. The decrease was probably the result of some degradation below Lock and Dam 26, which was completed in 1938. The increase in 1960 corresponds to the completion of Dam 27 downstream.

The records at Keokuk gage, immediately below Lock and Dam 19, also show a decrease in minimum annual stage in the period between 1920 and 1940.

Table 4-10

Top-Twenty Stages
Mississippi River at Hannibal

Rank	Stage ft	Year
1	28.59	1973
2	24.59	1965
3	24.1	1947
4	23.4	1960
5	22.6	1951
6	22.53	1944
7	22.5	1903
8	22.5	1969
9	22.1	1929
10	21.8	1888
11	21.67	1952
12	21.6	1948
13	21.6	1851
14	20.9	1962
15	20.8	1897
16	20.8	1892
17	20.6	1881
18	20.1	1919
19	19.8	1945
20	19.7	1967

Period of record: 1851 to 1973

The locks and dams have affected minimum stages immediately upstream of locks and dams as shown in minimum stage records at Hannibal and Grafton. Records of both the Grafton gage in Pool 26 and the Hannibal gage in Pool 22 shows a large increase in annual minimum stage after 1940. This increase is a result of operating the dams to raise the minimum pool elevation during low flow.

Table 4-11

Top-Ten Flood Discharges
Mississippi River at Hannibal

Rank	Discharge cfs	Year	Rank of corresponding stage
1	381,000	1973	1
2	342,000	1960	4
3	340 000	1965	2
4	335,000	1903	7
5	323,000	1947	3
6	323,000	1944	6
7	300,000	1951	5
8	275,000	1952	10
9	273,000	1962	14
10	273,000	1948	12

Period of record: 1903 to 1906, 1912 to 1973

The unusual form of the low stage curve at Meredosia on the Illinois River (Figure 4-4) also reflects the influence of man (Oglesby et al., 1972). The upward trend initiated in the 1890's corresponds with water diversion into the Illinois River through the Illinois and Michigan Canal. According to Starrett (Oglesby et al., 1972),

> Between 1900 and 1938 the average amount of Lake Michigan water diverted into the Illinois River system through the Chicago Sanitary and Ship Canal was 7,222 c.f.s. The diversion during this period ranged from 2,990 c.f.s. in 1900 to 10,010 c.f.s. in 1928. A decree of the United States Supreme Court limited the amount of diversion after 1938 to 1,500 c.f.s. in addition (sic) to the domestic pumpage of Chicago.

Increasing minimum stages since 1940 reflect the influence of Pool 26 on the Lower Illinois River.

In summary, the trends in the Historical record of discharges and stages in the study reaches of the Upper Mississippi and Lower Illinois River are placed in Table 4-12.

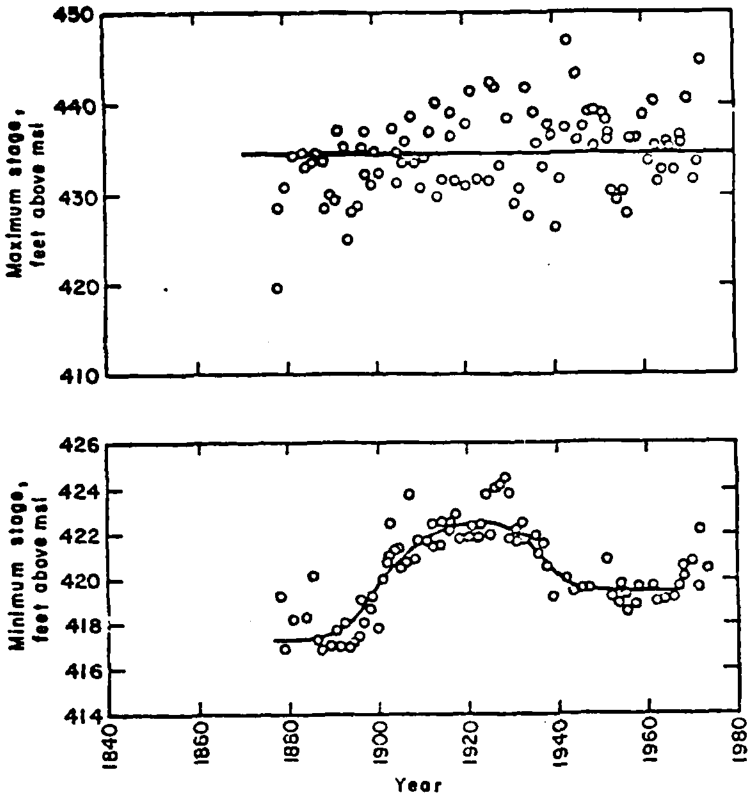


Figure 4-4 Annual stages at Meredosia

Table 4-12

Trends in Annual Discharges and Stages

Location	Discharges Maximum	Discharges Mean	Discharges Minimum	Stages Maximum	Stages Minimum
Mississippi River:					
Alton	None	Up	Up	None	--
Keokuk	None	Down	Up	None	--
Hannibal	--	--	--	Up	Up
Grafton	--	--	--	None	Up
Illinois River:					
Meredosia	None	None	None	None	Up

The pronounced degradation and a large increase in the number of islands in Pool 24 were the most noticeable immediate responses of the Upper Mississippi River to the construction of Locks and Dams 24, 25 and 26 and other dams upstream.

After 32 years of operation, the riverbed in Pool 24 had aggraded slightly but was not yet to its level prior to the construction of Locks and Dams 22 and 24. In Pools 25 and 26, the average riverbed levels in 1971 were lower than in 1929.

In Pool 25, submergence of part of the Illinois floodplain caused by the closure of Lock and Dam 25 resulted in a 9.3 percent increase in surface area of the river. Overall, the surface width of this reach widened approximately 580 feet. Also, the number and surface area of island in Pool 25 increased. Those in the lower end of the pool decreased in size and those in the upper end enlarged. The sand transport capacity of the 1973 river in Pool 25 was approximately 3,100,000 tons/year, increased slightly since 1929.

There are more side channels in the study reach of the Upper Mississippi River after 34 years of lock and dam operation than there were prior to dam construction. The long chutes in Pool 25 have hardly changed in this 34-year period.

The levees in the study reach have had no appreciable effect on the flood peaks in the reach. However, many of the tributaries on the floodplain have aggraded due to the increased low-flow stages in the Pools.

Annual flood discharges at Alton, Illinois and Keokuk, Iowa have remained unchanged in the last 110 years. The mean annual and annual minimum flow at Alton have been increasing slightly. Flood stages at Alton are approximately the same in the present-day river as in the river before locks and dams.

Generally, annual minimum stages decreased immediately below locks and dams and increased appreciably immediately above.

4.1.2 EFFECT OF CHANNEL MAINTENANCE

4.1.2.1 Locks and Dams

The significant impact of maintaining Locks and Dams 24, 25 and 26 is the maintenance of navigation on the Mississippi and Illinois Rivers. Dam structures have the effect of maintaining a given volume of water in each pool to provide a sufficient depth of water for a 9-foot navigation channel. The dam structures have minimal impact when the maximum regulated pool is exceeded at times of high water flow thereby causing the condition of open river.

Operation of Locks and Dams 24, 25 and 26 cause localized hydraulic effects in the vicinity of these structures. Water flowing through the locks and dams generates a venturii effect on the downstream side of the structures. This means that the velocity of the water is greatly reduced just after passing through the constriction of the dams and some suspended solid material may be settled out of the water column. It is noted that several frequently dredged areas are immediately downstream of dams. This type of sedimentation tends to stimulate the need for recurring dredging near the structures.

The purpose of the locks is to permit the passage of vessels by the dams. Locks do not have any effect on water surface elevation in the pools. The locks are electrically operated and the amount of energy expended in lock operation is considered to be insignificant.

The operation of locks to pass vessels by the dam structures is essential to the maintenance of commercial and recreation navigation on the upper Mississippi River and the lower 80 miles of the Illinois River. Increased recreational potential has resulted due to the greater water surface area within pools 24, 25, and 26.

Stable pool conditions also provide communities along the Mississippi and Illinois Rivers with a reliable municipal water supply by keeping the water intake valve submerged.

4.1.2.2 Dredging and Placement

An average of 1.9 million cubic yards of material is dredged annually in Pools 24, 25 and 26 (Mississippi and Illinois Rivers) to maintain a 9-foot navigation channel. Table 4-13 shows total quantities of material dredged from the Mississippi and Illinois Rivers from 1963 through 1974. Troublesome channel crossings are graphically displayed on Plate 9A-D for a period from 1969 through 1974.

Dredging activities in the Mississippi River range from approximately 0.8 to 1.9 million cubic yards of material dredged on an annual basis. Channel crossings in the reach from Saverton, Missouri to Alton, Illinois are dredged when they have been identified by either the Corps of Engineers sounding vessel Pathfinder or commercial tow operators. The dredge material in this reach is placed either adjacent to the main channel or near the right or left bank of the river. Coordination with respective state and federal conservation agencies is maintained to ensure that the placement of dredge material is in locations suspected to have the lease adverse impact. However, dredge material is not always placed at locations which are in agreement with the respective conservation agencies due to the discharge range limitations of existing plant facilities. (Reference page 208 Figure 6.3, Discharge Range Model).

Approximately 0.5 million cubic yards of material is dredged annually from the Illinois River from LaGrange to Grafton. Dredge material cut from troublesome channel corssings is generally placed near the bankline or slightly overbank depending upon the river stage at the time of the dredge cut. Again, coordination is

maintained with respective state and federal agencies so as to place the dredge material (within the limitations of plant capabilities) at locations which are suspected of having the least adverse impact. The placement of material has little or no effect upon agricultural soils, as overbank placement is usually confined to a limited area between the levee and the river bank.

In both the Mississippi and Illinois Rivers, efforts are made to avoid the placement of dredge material in locations where it could enter or block side channel openings. Due to the limitation of existing plant facilities (dredge Kennedy and Ste. Genevieve), it is not always feasible to place dredge material at desired placement sites.

Figure 4-5 illustrates those channel crossings which have been dredged on a recurring basis. Given a comprehensive dredge cut plan, it may be possible to eliminate recurring dredge cut sites with more extensive dredging of those areas which must now be dredged annually.

Table 4-13

Summary of Dredging 1963 - 1974
(In cubic yards)

Year	Mississippi River	Illinois River
1963	1,081,800	737,000
1964	838,600	---
1965	1,390,200	563,200
1966	1,613,000	278,000
1967	1,842,100	573,800
1968	1,882,200	202,700
1969	1,598,400	1,632,200
1970	1,339,600	453,700
1971	1,209,700	779,900
1972	1,453,600	1,453,600
1973	997,900	---
1974	1,627,000	---

Table 414 shows the percentage of total channel length dredged in miles for the 105 miles of the Mississippi and the lower 80 miles of the Illinois River. From the period of 1965 through 1974 the maximum amount of dredging was recorded at 8.5% (or 8.6 miles) of the total channel length in the Mississippi River. This occurred in 1974 a year after the flood of 1973. The minimum recorded dredging was 3.3% of the total channel length. For the ten year period from 1965 through 1974 the average annual dredging is approximately 6%. From the period of 1965 through 1974 the maximum amount of dredging was recorded at 7.6% (or 6.1 miles) and the minimum of no dredging in 1973 and 1974.

Figure 4.5

RECURRING DREDGE CUTS
1964 thru 1974

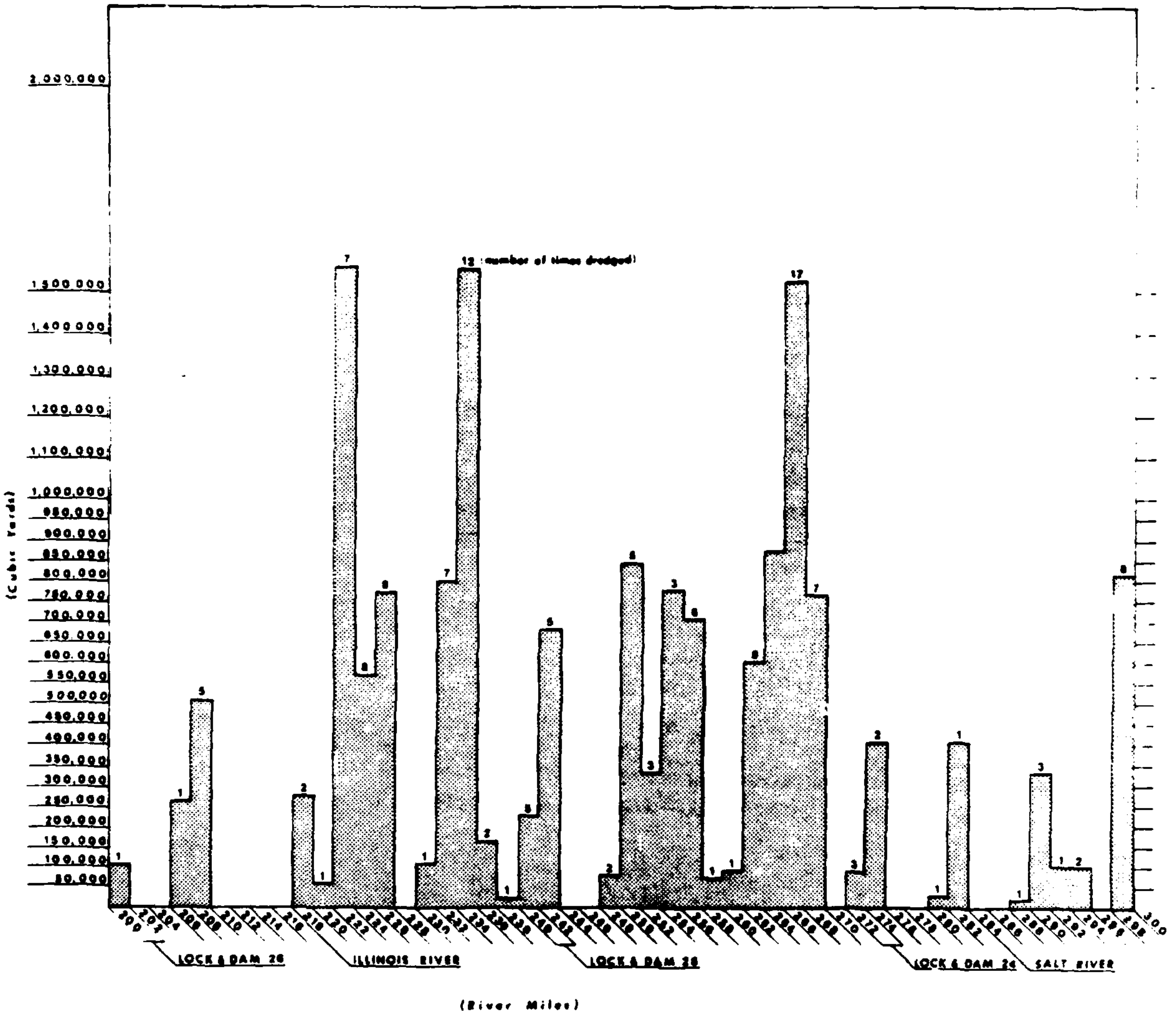


Table 4-14

Percentage of the Channel Dredged
Mississippi River (105 miles)

Year	Number of Miles Dredged	% of Total Miles
1974	8.6 miles	8.1%
1973	8.2	7.8
1972	7.3	7.0
1971	3.5	3.3
1970	6.0	5.7
1969	4.8	4.5
1968	8.1	7.7
1967	7.9	7.5
1966	5.8	5.5
1965	4.2	4.0

Illinois River (80 miles)

Year	Number of Miles Dredged	% of Total Miles
1974	0	0
1973	0	0
1972	6.1	7.6
1971	3.5	4.3
1970	1.6	2.0
1969	4.1	5.1
1968	1.0	1.2
1967	2.8	3.5
1966	1.7	2.1
1965	2.4	3.0

Plates 10 and 11 are a matrix of dredging locations from 1963 through 1974 for the Mississippi and Illinois Rivers respectively. While this matrix identifies dredging locations by two mile increments, it should be noted there are numerous reaches of the river which have not been dredged or dredged only on an infrequent basis over the last eleven years.

Plates 12A-P show placement capabilities at previous dredge cuts. In reaches noted as critical areas, the placement of dredged material could be accomplished in such a manner as to have the least adverse impact while still providing acceptable recreational beaches. Previous efforts have been made to identify desirable dredge material placement sites from a conservation viewpoint (Robinson, 1969). An example of how dredge material can be used with the least adverse impact may be illustrated by utilizing recommended placement sites selected by conservation agencies in the critical areas identified on Plage 12B.

4.1.2.3 Dikes Revetments

The significant impact of maintaining dikes is to aid in maintenance of navigation and to prevent channel migration. The dikes on the Upper Mississippi are constructed to a relatively low elevation and are perpetually submerged in the downstream reaches of the pools. However, dikes control the flow patterns sufficiently to effectively help in retaining the depth of the navigation channel along a satisfactory alignment.

Lengthening low dikes can be effective in increasing the depth in the navigation channel. Increasing the height of a low dike field can also be effective in producing a dependable navigation channel if the dikes are not too short in relation to the river width. In the study area, there are no new dikes planned.

Revetments are used in the Upper Mississippi River to help stabilize the bankline. Their impact is one which reduces the potential for bankline erosion thereby eliminating a possible source of sediment for introduction into the river. For a period of 40 years (1930 to 1970) there was no active maintenance of bankline structures within pools 24, 25 and 26. In 1970, an active program of maintenance and reconstruction of revetments was initiated. From 1970 through 1974 most major bankline structures were repaired.

4.1.3 IMPACT ON GEOLOGIC ELEMENTS

4.1.3.1 Impact on Groundwater

Near the downstream end of each navigation pool groundwater may flow from the pool landward into the aquifer during periods of low precipitation. This water is generally free of disease-carrying bacteria and suspended solids because of the filtering action of the aquifer materials.

4.1.3.2 Impact on Tributary Streams

During periods of low flow in the rivers the gates on the dams are lowered to maintain the pool level. There is evidence that some of the tributary creeks have silted up near the confluence with the river. It is difficult to ascertain the amount of siltation caused by operation of the pools and siltation that is the result of agricultural practices and urban construction.

4.1.3.3 Impact on Economic Geology

The construction of dikes and revetments and the operation of the dams may cause siltation of finer particles over sand and gravel deposits, thus eliminating these resources from economic exploitation. If a decision is made to stockpile dredge material for fill or construction purposes this action would effect the commercial operations in the study area. At this time, dredge cuts and open water disposal have little effect upon the numerous sand and gravel deposits available for exploitation.

4.1.4 IMPACT ON WATER QUALITY

4.1.4.1 Dikes and Revetments

In the Upper Mississippi River there have been no new dikes built since the navigation pools were constructed, but they have been repaired (i.e., restored to their original elevation). The effectiveness of the dikes has been reduced because of the increased water level and decreased stream velocities caused by the dams. In the lower portions of the pools the dikes have been submerged, but in the upper end of the pools dikes are sometimes exposed.

In the upstream portions of the pools where the dikes are still functioning, the increased velocities still maintain sufficient sediment transport capability to keep the coarser material suspended until it reaches the slack water of the lower portion of the pool. Dikes also function in downstream portions of the pool, but to a lesser extent.

During revetment and bank preparation activities, short-term increases in turbidity will result. Once river banks are stabilized by revetment, rates of erosion diminish and these areas contribute less turbidity than unprotected banklines due to the lesser rate of erosion.

4.1.4.2 Maintenance Dredging and Placement

A factor of major concern is the adverse effect of dredging and placement of dredged material on water quality. Increased turbidity along with increased siltation are probably the most detrimental factors associated with dredging. One of the primary effects of turbidity is reduced light penetration which interferes with primary production by photosynthesis. Turbidity has also been noted to cause flocculation of planktonic organisms, decrease food availability, influence temperature patterns, cause a shift from game fish to rough fish, and produce effects that are aesthetically displeasing. Turbidity may also result in abrasion or clogging of fish gills and abrasion of other aquatic organisms. However, this turbidity caused by dredging is a transient condition that only exists in a limited area and only for a short period of time. Some effects of sedimentation are smothering of benthic organisms, destruction of spawning areas for fish, reduced habitat diversity, and reduced vegetation cover.

The disruption of sediments may generally be expected to enhance the exchange of chemical constituents if they are present. This turbulence increases the surface area of solids exposed to the water and transports interstitial waters to the sediment-water interface. There may be changes in the microenvironment as the sediment is disturbed. Changes in the oxidation potential, pH, ionic strength and dissolved oxygen concentrations may occur. These factors are known to influence absorption, chelation, and chemical bonding forces which may be acting to bind chemical constituents to sediment particles and are the factor determining the actual effect of dredged material on water quality.

Pesticides, metals, sulfides, methane, oil and grease, ammonia, or other substances, if present in bottom deposits, can be released to the water column by resuspension of the sediment or from runoff from land disposal areas. Resuspension of organic matter and nutrients could also occur from the sediments. The organic matter could cause increased chemical oxygen demand in the water and the resulting decomposition could cause a reduction in dissolved oxygen concentrations if it remains suspended long enough to have a significant effect. However, analysis of nutrients, heavy metals and other chemical constituents in sediment samples collected from the main channel for the present study by the Waterways Experiment Station (WES) indicate that,

for at least this pooled reach of the river, the impact would be minimal. In a study of hydraulic dredge effluent from the Upper Mississippi and Lower Illinois Rivers in the St. Louis District none of the parameters measured exceeded EPA criteria cited in Boyd et al. (1972) (Appendix B, Table 9). Of the heavy metals examined by WES only total iron exceeded EPA criteria. During dredging of the river channel ferrous iron existing under anoxic conditions in the sediments would quickly be oxidized to its insoluble form and become unavailable for utilization by algae. The release of nutrients in the water column during dredging and the subsequent potential enhancement of eutrophic conditions has also been a major environmental concern. Eutrophication expressed as excessive algae growth is dependent on algal utilization of nutrients. Nutrient utilization by algae depends on (1) the chemical form of the nutrients, (2) the biological availability of the nutrients, (3) the nutritional status of the algae, and (4) limiting nutrients or other limiting constituents, such as light. Those items listed above must be considered in any discussion of eutrophication. Simply stated, the presence of nutrients in sediments does not necessarily translate to eutrophic conditions upon their release in the water column.

In addition to the immediate turbidity generated during dredging, dredged material is eroded to some extent by water. This affects areas that are situated close to the disposal site. Dredging near the entrances of side channels through which current flows may result in increased sedimentation rates caused from future wind and water erosion. Generally, the effects of dredging on water quality appear to be localized. That is, significant downstream changes in the chemical parameters measured would not appear to have long-term consequences. Dredging creates a local distrubance and the affected water quality parameters return to their pre-dredging status in a relatively short period of time.

The dredged material generated through the maintenance of the navigation channel is generally deposited alongside the channel in either the river border area (which includes considerable dike habitat) or on existing low sand masses. The dredged material can sometimes spread out into off-channel areas, affecting several types of shallow aquatic habitats such as marshes, flood plain lakes, and ponds.

It is not possible to completely isolate the impacts of dredged material from the natural movements of sediment and the erosion and turbidity resulting from the movement of barge tows. It is well established that, within the study reach, bottom sediments are continually being resuspended naturally; to a degree, open-water disposal of dredged material can be thought of as a very minor extension of the natural processes at work. The similarities end here, however; open-water disposal usually results not only in the resuspension of larger volumes of sediments within a very short time and in a limited area, but also the resuspended sediments may contain chemicals and

nutrients that, through the process of dissolution, may enter into solution with water and may adversely affect biological communities.

Most of the concern associated with the placement of dredged material involves the effects of open-water disposal on water quality and aquatic organisms.

The placement of dredged materials in critical areas, such as areas near the entrances or exits of side channels, may have deleterious effects. The direct placement of dredged material in these locations could block the flow of water through the side channels and thereby could alter existing physicochemical characteristics. Consequently placement in these areas is now avoided.

4.1.4.3 Operation and Maintenance of Locks and Dams

The rate of atmospheric reaeration of the river is affected by turbulence resulting from stream velocities and the surface area/volume ratio. Closing of the dam gates would decrease flow and raise the water level causing a reduction in the surface area/volume ratio of the pool, resulting in decreased atmospheric reaeration. Since the dams are not for flood control, i.e., no flood control storage capacity, they only reduce flows (discharge) for a very short time during gate closure. Also substantial improvements in dissolved oxygen concentrations are realized downstream from dams, sometimes for a considerable distance, because of the turbulence associated with water passage over the dam.

A lack of turbulence may exist in those backwater areas where minimal water circulation is available. Decomposition of organic material in these areas will reduce dissolved oxygen concentrations. Dam operations, specifically the regulation of pool surface elevations, may be used as a tool to flush out backwater areas. Increased circulation in backwaters during periods of rising pool elevation would alleviate dissolved oxygen depletion problems. However, it is not always possible to closely regulate pool elevation. There are additional maximum and minimum constraints on operable pool elevation because the project purpose is maintaining a navigation channel so it may not be possible to realize improvements in backwater dissolved oxygen via dam operations.

The reduced stream velocity in the pools will allow large amounts of suspended solids to settle out, resulting in increased transparency of the water. While the production of plankton and potential for increased photosynthesis is enhanced under these conditions, sedimentation is increased and its adverse impact is reflected in the loss of aquatic habitat through the eventual change to terrestrial habitat. Reduced current velocities also allow accumulation of nutrients, which could lead to eutrophic conditions.

Concentrations of nutrients analyzed from sediment samples collected from main channel areas in the Middle Mississippi River during September, 1973 (Solomon et al., 1974) were generally lower than nutrient concentrations analyzed from sediment samples collected from impounded reaches of the river during September 1974 of the present study. Neel (1951) and Minckley (1903), cited by Hynes (1972), studied the effect of pools on the concentrations of dissolved oxygen and carbon dioxide in streams. They showed that pools tended to reduce the oxygen and increase the carbon dioxide content of the water as it passes through. Hynes (1972) stated that large rivers may display such features and cites the White Nile as an example. Changes in temperature regimes due to reduced flow have also been observed.

The operating machinery and gates of the locks and dams require periodic cleaning and lubrication of moving parts. Despite precautionary measures, lubricating materials could be spilled; the quantities involved, however, are extremely small and have negligible effects downstream.

4.1.4.4 Accidental Spills from Barges or Pipelines

Federal and State regulations prohibit the purposeful discharge of waste into the river, and such regulations greatly reduce the amount of waste entering the waterway. The greatest potential for accidental discharge of hazardous materials exists during the loading and unloading of barges, but occasional losses occur through barge wrecks or hard groundings and accidental pipeline breakages. The U.S. Coast Guard is responsible for measures to reduce the likelihood of spills and to minimize damage caused by spills that occur despite preventive measures.

The impacts associated with spills of light petroleum products, such as gasoline or fuel oil, differ in some respects from impacts associated with loss of such heavy petroleum products as asphalt. Light materials cover large water areas quickly, making containment difficult, causing safety hazards and air pollution. Currents and waves may cause emulsification of the petroleum with water. In this form, light oils are highly poisonous to fish, shellfish, benthos, and other aquatic organisms. Water-associated birds and mammals also may be directly poisoned. Severe aesthetic and biological harm may result from the discharge of medium-weight petroleum products. Little of such spills is lost to the atmosphere. However, spills not promptly contained coat beaches and marsh habitats. In severe cases, swimming reptiles, birds, and mammals may be covered with oil. When heavy petroleum products are spilled, limited local impacts result from heavy components of the mixture, but widespread impacts of the types just described are caused by escaping volatile components.

Large quantities of anhydrous ammonia are also transported by barge. Anhydrous ammonia is very water-soluble, and is highly poisonous to humans and other organisms. While slow leakage of ammonia might have only slight impacts on aquatic organisms, due to rapid dilution with river water, a sudden loss of large amounts could poison the water column of the channel and backwaters for an indefinite period and distance downstream. Direct poisoning of aquatic and water-associated organisms could be accompanied by indirect disruption of the ecosystem due to loss of food sources of predators and scavengers. Municipal water supplies could be affected by spills upstream of intakes. Because containment of discharged ammonia is impossible, dilution must be relied upon to eliminate further danger of poisoning. For this reason, flow rates at the time and place of spillage are important determinants of impact. The greater danger of tow accidents associated with flood-level flows may thus be ameliorated by reduction of environmental impacts of spills by the high dilution capacity of high flows.

As indicated by data from the U.S. Coast Guard Pollution Incident Reporting System for the entire Mississippi and Illinois Rivers, in 1974, river transportation (both thru vehicles and transfer facilities) account for the greatest amount of pollution, 210,947 gallons. Of this total amount, those commodities spilled in greatest quantities were light petroleum products (gasoline, kerosene, and diesel oil) and liquid chemicals (acetones, acids, alcohol and formaldehyde). Both rail and pipeline accounted for a surprisingly large amount of water pollution in 1974. Water pollution from rail sources (thru vehicles and transfer facilities) totaled 1,089 gallons, with liquid chemicals accounting for 1,000 gallons. Pipeline transportation accounted for 1,130 gallons, all from light petroleum products. However, it is not surprising that river transportation was the largest source of pollution, because of course, it is at all times proximate to the water.

4.2 BIOLOGICAL IMPACTS

4.2.1 AQUATIC COMMUNITIES

4.2.1.1 Dikes and Revetments

a. Dikes. Dike construction began on the Upper Mississippi and Lower Illinois Rivers in the late 1800's. Work of this type was actively continued until 1930 when the 9-foot channel was authorized. The resulting permanent change in water levels submerged dikes that were constructed earlier. Since 1968 and on a limited basis, maintenance has been resumed for selected dikes that have degraded significantly. Dikes are not maintained on a schedule but as a reaction to dike failures. Dike failures include subsidence of the unattached ends and detachment of the ends from the shoreline. Response to

changes in flow characteristics sometimes includes increasing the length of dikes to previous dimensions or adding to the unattached ends.

Dikes are repaired by dumping rock precisely on the desired location with either a dragline or a clamshell bucket. Water quality at the construction or repair sites is degraded temporarily as fine material accompanying the rock passes into suspension and fine bottom material stirred up during construction is resuspended. The material settles downstream at various distances from the site and may cover benthic organisms. The distance that the sediment is transported varies with flow rates at the sites and with sizes of sediment particles. Increased turbidity persists longer in situations that require additional shaping of the structure with a dragline.

New segments of dikes cover benthic organisms. The quantity destroyed depends upon the area covered and the concentration of the organisms; both vary from site to site. However, no new dikes are being constructed in the project area.

Long after their construction, dikes continue to function as water deflectors, directing the bulk of flow along the desired pathway. This increase in flow rate is intended to help keep the channel open for navigation. The faster moving water has the additional effect of sorting sediments passing along the course of the river: silt-sized particles pass through channel areas in suspension, while sands are added to the relatively coarse channel bed and moving bed load. Sands of the bed load are moved or renewed quite regularly by the water currents, creating a rather unstable habitat for benthic organisms.

The reduced flow rates behind dikes induce deposition of the finer, silty materials suspended in the main channel waters or tributary waters that enter through or near these backwaters. Such variations of flow rate occur in a natural river of this configuration, but are heightened to various degrees by the placement and maintenance of regulatory works associated with the navigation system. Sedimentation consequently has increased and has reduced the amount of aquatic habitat within dike fields.

Although further investigations are needed, dikes have been reported to provide habitat for some benthic organisms. Johnson, et al. (1974) observed large densities of nonburrowing mayflies and caddisflies on stones from which dikes were constructed in the Middle Mississippi River. In their biological inventory of the Upper Mississippi and Lower Illinois rivers, WES found that dike areas in the Mississippi River ranked second, behind side channels, on the basis of mean standing crops (numbers and biomass) of benthic organisms. For the Illinois River, the single dike area sampled supported the largest standing crops of benthic organisms compared to other habitats.

b. <u>Revetments</u>. To aid in the maintenance of the navigation channel, certain critical shoreline areas have been protected with revetments to prevent erosion. To date, no studies have been designed to evaluate the impacts of revetments on the flora and fauna of the river. When a shoreline is revetted, changes in the composition and abundance of the associated biota occur due to the changes in habitat, such as the loss of root wads and fallen trees associated with natural shoreline. Along shorelines that support diverse and large standing crops of aquatic organisms, revetment work undoubtedly destroys those communities at the construction site. Usually, shoreline in need of revetment is located in areas where erosion is maximal, so much so that aquatic communities may be limited. The impacts on aquatic communities in these areas may therefore be minimal. The habitat formed from the stone used in the construction of revetments has also been presumed to provide additional habitat diversity for aquatic communities and therefore may be beneficial.

4.2.1.2 Maintenance Dredging Placement of Dredged Material

a. <u>Dredging operation</u>. Dredging is required to maintain navigation in the main channels of the Upper Mississippi and Lower Illinois Rivers. In the past, much of the concern associated with dredging involved the direct destruction of benthic communities that are an important part of the riverine ecosystem. It is generally agreed that the mechanical effects of dredging directly destroys benthic organisms. Although this concept is widely accepted, it should not be interpreted to mean that all benthic organisms are destroyed during the dredging process. Presumable, the degree of destruction is dependent upon such considerations as the type of dredge used and suitability of main channel areas as habitat for benthic population.

In a study where a bucket dredge was used to clear the channel of sediments from the Providence River, Saila, *et al.*(1972) observed that several species of benthic organisms survived the dredging process and were found to occur at the disposal site immediately following disposal. Considering the operational features of various dredge types, it would seem reasonable that hydraulic dredges would be the most destructive and mechanical dredges the least destructive to established benthic populations. Furthermore among hydraulic dredges the cutterhead dredge would be more destructive than a dustpan dredge. Maintenance dredging in navigation pools 24, 25 and 26 of the Upper Mississippi is primarily accomplished by dustpan hydraulic dredges. The cutterhead dredge is utilized on the lower Illinois.

The suitability of the main channel habitat for benthic organisms must also be considered in any discussion concerning the impact of dredging on benthic communities. In WES's study of this project area, and in a study conducted in the Middle Mississippi,

River by Solomon, et al. (1974), it was found that main channel areas, which are characterized by strong current and shifting substrates, support the lowest standing crops of benthic organisms when compared to other habitats. Solomon, et. al. observed the lowest abundance and diversity of benthic organisms for main channel dredged sites, greater abundance and diversity for placement sites, and highest abundance and diversity in river border areas. In WES's study of this project area, main channel areas sampled in both the Mississippi and Illinois Rivers characteristically showed lower densities (both in numbers and in biomass) than were observed for river border areas, dike areas, and side channels. The direct destruction of benthic organisms by dredging may be of minimal environmental impact so long as dredging is confined to main channel areas.

Indirect effects on aquatic communities as a result of dredging are also an important concern, although much more difficult to evaluate. The potential for indirect effects is most often attributed to physical alterations of the environment and resuspension of toxic materials and nutrients in the water column. Among the physical alterations resulting from dredging are changes in bottom geometry and bottom substrate that cause subsequent alterations in turbidity levels, current patterns, velocities, and nutrients or toxic chemicals exchange between sediment and the overlying water. These effects are discussed in Part 4.1.4.2.

b. Placement. Direct effects of the placement of dredged material include the possible destruction of spawning and nursery areas for fish and the reduction of habitat diversity. Placement may also result in the smothering of many benthic organisms and in the displacement of other aquatic organisms.

Most of the concern associated with the placement of dredged material involves the effects of open-water placement on water quality and aquatic organisms and the closure of side channels. Short- and long-term effects of open-water placement operations include:

a. Increased turbidity which reduces light penetration and, therefore, may interfere with primary production, flocculate plankton organisms, decrease food availability, and produce effects that are aesthetically displeasing.

b. Increased sedimentation that could result in the smothering of benthic organisms, destruction of spawning areas for fish, reduced habitat diversity, and reduced vegetation cover.

c. Reduction of dissolved oxygen concentration that could suffocate or stress organisms in the immediate vicinity and/or release noxious materials, such as sulfides, methane, and heavy metals, into the water column. These effects on aquatic communities are expected to be minimal so long as placement is confined to main channel areas (open water placement)

The placement of dredged materials in critical areas, such as areas near the entrances or exists of side channels, both natural and those created by construction of the dams, may have deleterious effects. The direct placement of dredged material in these locations could block the flow of water through the side channels and thereby prevent the movement of fish between side channel and river. Placement activities are coordinated with conservation agencies in order to avoid such environmentally critical areas.

4.2.1.3 Operation and Maintenance of Locks and Dams

The general effect of operation and maintenance of locks and dams on the aquatic communities of Pools 24, 25 and 26 of the Upper Mississippi River and the Lower Illinois River has been quite favorable. The aquatic habitat has been increased both in area and diversity. The combination of reduced turbidity and increased off-channel habitats, which provide shelter and spawning areas for many species of fish, are primarily responsible for general increase in abundance of most biological components of the aquatic system.

Operation and maintenance of the pools on the Upper Mississippi River and the Lower Illinois River has been credited by a number of sources with the production and maintenance of a diverse and abundant fish fauna (Barnickol et al. 1951; Colbert, et al., 1975; Pflieger, (1971). However, a number of individual fish species may have been adversely affected by impoundment. Spawning of the blue sucker, Alabama shad, and skipjack herring may have been impaired, and the upstream migration of nine other species may have been inhibited to their detriment (See paragraph 2.2.1.2). The decline of several sport and commercial species of fish, including sturgeon species, paddlefish, and the American eel has been attributed to impoundment, along with other factors, such as chronic industrial and municipal pollution and drainage or filling of bottomlands.

4.2.2 TERRESTRIAL COMMUNITIES

4.2.2.1 Impact on Vegetation

Levee. The botanical impacts of levee construction are (a) that construction causes destruction of plants and plant communities at the site and adjacent to the site, (b) that levees make the internal habitat drier, resulting in a more rapid rate of succession, and (c) that because internal habitat becomes drier, more forestland is cleared for agriculture.

Revetments. Five mainland revetments and two island revetments were studied with regard to vegetation. Fifty-five plant species were found on the mainland revetments and 27 on the island revetments, with only 4 species in common. The flora of the island revetments was very

similar to that of a small fast-growing island. Species found on the two revetment types are listed and discussed by Klein, *et al.* (1975), but none of these are endangered or threatened and they do not appear to have great taxonomic or ecological significance.

No important botanical species or their habitats are likely to be destroyed by the construction of revetments.

Overbank Dredged Materials. Dredged materials deposited overbank have the direct effect of killing the covered vegetation. However, floodplain vegetation near the river has less diversity to it than that away from the river and few important species occur there. Succession proceeds on these materials as on growing islands and on island revetments, although both cover and number of species are generally low. Clay lenses in the materials yield greater numbers of species and greater cover. Dredge materials therefore seem unlikely to have important impacts either by virtue of the vegetation smothered or the vegetation developing on them.

Pool Regulation. Pool regulation resulting from locks and dams has resulted in a minor fall in low water levels below dams and a major rise in levels in the pools above. Since communities are distributed in bands or zones more or less parallel to the river, this would be expected to cause a shift in these zones toward the river below dams and away from the river above. This suggest an increase in marsh and emergent aquatic habitats in the pool margins, and a drying out and speeding up of succession where the river becomes constricted. Pool regulation causes zones which are in and out of water and which are subject to wave action, but pioneer willow and willow-cottonwood communities are expected to develop rather quickly in such areas.

4.2.2.2 Impact of Wildlife

Research on the changes that have occurred in the Illinois and Mississippi Rivers as a result of extensive land clearance for agriculture, levee construction, barge traffic increase, and channel maintenance activities has been practically nonexistent. Since all these factors have had a collective impact on the rivers, it is difficult to single out the effects of any one of them to wildlife. In some cases, channel operation and maintenance activities have benefitted wildlife; in others it has been detrimental.

a. Dikes and Revetments

Emergent dikes are commonly used by birds and mammals, and produce some feeding areas for fish. The sediment accumulated behind emergent dikes tends to remain there permanently and may eventually cover the dike. Emergent dikes located between two land masses, such as those across a side channel to connect the mainland to an island,

tend to reduce the flow of water between the land masses and to increase the rate of siltation in the area. As the secondary channels become filled with silt and debris, willow trees invade the area and, in turn, cause more settling of silt by decreasing water velocity. Eventually, the ground elevation is raised sufficiently to allow agricultural activities (Hartke 1966). Submerged dikes are not commonly used by wildlife, although they can provide some habitat for fish. Accumulated material behind this type of dike rarely exceeds the height of the dike. While dikes provide some habitat for animals, the reduction of backwater areas and the possible acquisition of accreted lands for farming greatly outweighs any benefits to wildlife that might accrue by dike construction.

Bank revetment provides bank stability and reduces the silt load by preventing additional erosion. Revetment may provide cover for amphibians, reptiles, and small mammals, and feeding sites for fish; however, a bank protected by revetment can no longer sustain bank dwellers like the beaver and muskrat. Ecological diversity is reduced by the elimination of mud flats and shallow water areas along the shoreline.

b. Maintenance Dredging and Placement of Dredged Material

Most dredging and its placement in the project area takes place in the main channel where it has very little impact on terrestrial wildlife. However, placement of dredged material can create problems. Dredged material placed at the entrance to a side channel accelerates the rate of sedimentation in the channel, which in turn increases the rate of succession from an aquatic to a terrestrial environment (McDonald and McDonald 1973). Problems are also created by the dredged material drifting into and blocking slough areas (McDonald and McDonald 1973; U.S. Army Corps of Engineers 1972).

Dredged material placed on land, especially on riverbanks, can temporarily or permanently eliminate the vegetation, bank dwelling mammals, and amphibians. If the material is sand, turtles may use it as spawning area. Material placed within the river proper provides loafing and resting habitat for various birds.

Since the dredging season lasts from April through December, dredging could have a local effect of disturbing migrating waterfowl in the vicinity of the dredging operation. This disturbance would be for a short period of time in a local area. A more permanent impact, as mentioned above is the covering of benthic organisms by dredge material. This has an adverse impact on benthic feeders such as waterfowl and wading birds. The loss of backwater areas would adversely affect migratory as well as breeding waterfowl and wading birds.

c. Lock and Dam Operation

The construction of navigation dams in the project area initially created extensive wetland habitats; however, the value of

these backwater areas has been greatly reduced by subsequent siltation (McDonald and McDonald 1973). Although the loss and gain of wetlands is a natural process in any dynamic river system, flood protection structures and channelization activities have reduced the area of the floodplain and prevents the creation of new wetlands to replace those lost. With the loss of these wetlands, those species, such as shorebirds, waterfowl, muskrats, and salamanders, which require shallow water areas would decrease. This land is usually exceptionally fertile, and the pressure to convert it to agricultural purposes would be great, thereby eliminating habitat for terrestrial animals.

Wave action caused by barge traffic and recreational traffic on the Mississippi River may adversely affect riverbank stability. Once vegetation is established on banks, the effect of waves will be dimished, but the value of the successional riverbank habitat to wildlife might be reduced in some cases. Riprap is necessary in some areas to control bank erosion.

Barge traffic on the river results in the potential risk of accidental spillage of pollutants into the river. Federal and State regulations prohibit the purposeful discharge of waste materials into the river, however, the effectiveness of these regulations is difficult to determine. Barge traffic may also disturb migrating waterfowl but the impacts are not presently known (St. Louis District Corps of Engineer 1975. Draft Supplement EIS, Locks and Dam 26).

4.2.3 IMPACT ON THREATENED, RARE, AND ENDANGERED SPECIES

Habitat destruction, pollution, commercial exploitation, indiscriminate, and illegal hunting, and pesticides have all contributed in varying degrees to the status of the 47 rare and endangered mammals, birds, amphibians, and reptiles expected to occur in the project area (See Appendix C, Table 46). Three of these species; Indiana Bat (Myotis sodalis), Bald Eagle Southern (H. l. leucocephalus), and Peregrin Falcon (Falco peregrinum anatum) are protected by the Federal Endangered Species Act of 1973.

Dikes and revetments change habitat diversity in the study area. Dikes contribute to silting in of sloughs and side channels. This will produce an adverse impact if such habitats are converted to agriculture. If conversion to agriculture results in large single crop fields, it would not be beneficial; however, many agricultural fields or newly formed islands are small, irregularly shaped and bordered by forest and do increase the habitat diversity. It is noted, however, that most conversion from sloughs to terrestrial habitat in the project area has to be considered adverse. Klein, et al (1975), indicate that revetments, while providing a unique situation, attracted no rare or endangered plant species.

While dredge material placement on land may temporarily eliminate bank-dwelling animals, new habitat in the form of sandbanks is created. River otters may be adversely impacted since they are

sometimes bank dwellers; however, some use upland nest sites. (Trippensee, 1953). Their food supply may be adversely impacted if the dredge material is placed in the water. The river otter is considered rare by Illinois and endangered by Missouri. One shorebird, the least tern, considered rare in both Illinois and Missouri, requires sandbanks for nesting, however, there are no known recent breeding records in the study area. The sandbanks created in mid-channel may also be utilized by birds, unless the banks are subject to appreciable human disturbance.

Pool regulation does not directly affect any rare or endangered species. Indirectly, the barge traffic can affect rare and endangered animals by adding pollution to the environment in the area of the river.

No impact on threatened, rare, or endangered terrestrial plant species is anticipated.

No direct impact is expected to occur to the Indiana bat since the project area is not important habitat for this species. The southern bald eagle and Peregrine falcon may be adversely affected by secondary impacts of the project. If the ducks, the Peregrine falcon feeds on are adversely affected by silting in of sloughs and side channels caused by dikes, this may adversely affect the Peregrine falcon. Similarly, for the southern bald eagle, if aquatic habitat in which the eagle feeds is reduced by silting caused by dikes, this may adversely affect the eagle. It is noted, however, that the primary cause in decline for the Peregrine falcon and southern bald eagle is reporductive failure that is believed caused by pesticides.

4.3 SOCIO - ECONOMIC IMPACTS

4.3.1 DEMOGRAPHY

The continued regulation of the 9-foot channel involves the activities of the revetments, dikes, and dredging. The construction and/or institution of these measures have no direct impact on the population. However, the product of the regulating works, i.e., the 9-foot navigable channel, does have an effect on the settlement pattern. This impact takes place at transportation termini, such as Alton, Louisiana and Meredosia. These river towns not only were founded because of river access, but continue to utilize the waterway. The comparative advantage afforded these communities by the presence of the waterway has attracted economic activities, that, in the absence of the waterway might have located elsewhere.

4.3.2 ECONOMY

4.3.2.1 Project Future

a. National Economy. Maintenance of the 9-foot channel in the project reach would allow for continued use of the river for inland navigation. The project will not alter the existing cost structure of water transportation, and thus should have no effect on the existing modal split, water, rail, pipeline, truck.

b. Regional Economy. The main impact of continued maintenance of the 9-foot channel on the regional economy will be to (1) maintain current level of shipping, and (2) allow for future growth of the waterway commerce industry, and industries using the water for shipping.

Maintenance of the channel will not in itself result in economic growth in the project area. By making possible the continued use of the waterway, shippers and industries will be able to continue to make use of the waterway. Savings in transportation costs thus realized will be reflected in profits and commodity prices.

4.3.2.2 Future Without the Project

a. National Economy. Non-maintenance of a 9-foot channel in the project reach would have substantial adverse impacts on the national economy. As has been noted above, this stretch of the river serves as a vital link between the Upper Mississippi, Illinois and Missouri Rivers to the north, and the Ohio and Lower Mississippi River to the south. In recent years, more than 85 percent of the total tonnage has been "thru traffic". Breakage of this link would vastly change the current modal split. The very substantial tonnage moving between the two systems via this part of the river would have to be diverted to other modes of transportation.

Other major commodity flows would also be expected to be disrupted; for example, the movement of coal and chemicals from the Ohio to the Upper River.

While short run traffic for the railroads, and other modes of transport would exceed the ability of those modes to handle it, substantial excess capacity might be expected to develop on other portions of the inland water system. Due to cleavage of the system into two smaller systems, both federally maintained navigation facilities and privately owned tows and barges would be underutilized, resulting in considerable economic waste.

b. Regional Economy. Discontinuation of operation and maintenance of this portion of the river would have varying impacts on different parts of the region.

A major position of commodities shipped in the waterway originating in the project area are grains. Substantial transportation savings to shippers are realized using the waterway. These savings represent increased revenue that can be used in other ways. A discontinuation of waterway service would force the utilization of other costlier modes of transportation. Higher shipping costs

would decrease from revenues and would represent a negative impact on farming operations, particularly on marginal operations.

Commodities brought into the area include coal and petroleum products. These materials are used primarily for electrical power generation. In a condition where the 9-foot channel was inoperable, these materials would have to move via other transportation modes. In such a situation increased transportation rates would be passed on to consumers in the form of higher electrical utility rates.

4.4 IMPACTS ON LAND USE

a. Introduction. The operation and maintenance of the 9-foot navigation channel has mixed impacts of urban and public land uses.

Urban Land. Except for the settlement of Alton and Meredosia, Illinois and Louisiana, Missouri, the urban centers along Pools 24, 25 and 26 are apparently passive to the existence of a navigable waterway insofar as measured by the origin or destination of shipments (see Section 2-3). This passiveness is further illustrated by the fact that of the tonnage carried on this stretch of waterway, over 85% is "thru traffic". Thus, disregarding the towns' initial location factors, little of their subsequent survival or expansion may be directly attributable to the waterway. Rather, except for the aforememtioned settlements, all of the towns along Pools 24, 25 and 26, have the physical characteristics of farming communities, i.e., type of retail establishments, relative lack of manufacturing, and type of services.

b. Recreation. Akin to urban development, though not mapped as a formal land use, are impacts on recreational developments. While the presence of navigation has little effect on the establishment of large parks, such as Pere Marquette State Park, near Grafton Illinois, or on the actual use of the River; the principle manner in which navigation is maintained, i. e., the pooled condition, enhances recreational development. As developed in Section 2-5, Pools 24, 25 and 26 provide a major recreation resource for the area. In turn, this resource provides the impetus for seasonal recreational developments along the banks of :the Mississippi and Illinois Rivers usually docks, concessions and homes. These developments are minor in magnitude, being scattered and of little depth. These developments occur on both private and public lands.

c. Public Land Another impact of the project, though unclear as to directness of its nature, is the presence of large tracts of public open land and its use for fish and wildlife management. As presented in Section 1-6, under the General Plan and Cooperative Agreement for the 9-foot navigation project each pool contains a large area of land (and water) managed for fish and wildlife purposes. These lands amount to over 8,000 acres in Pool 26. These areas are managed by cooperation of the Bureau of Sport Fisheries and Wildlife

with the states of Illinois and Missouri.

4.5 IMPACT ON OUTDOOR RECREATION

The regulating works will have little impact on existing recreational uses such as boating, water skiing, wading and swimming. However, sport fishing may sustain moderate to adverse impacts in selected areas during the performance of channel maintenance activities. Sections 4.2.1 and 5.2.3 contain a detailed discussion of expected impacts on sport fishing due to the operation and maintenance of the navigation channel.

4.6 IMPACTS ON CULTURAL RESOURCES

4.6.1 ARCHAEOLOGY

On the Upper Mississippi River in the study area few direct impacts of the operation and maintenance of the navigation channel are anticipated. Dredged materials are not placed on riverbanks for disposal, the construction or repair of bank revetments may have covered sites which may be located in these areas. Construction of revetments in some instances involves the contouring of river banks to the extent that disturbance of the ground surface takes place. Archaelogical resources that may be present could be adversely affected. To offset this possibility, all areas scheduled for revetment work involving disruption of the ground surface will be subject to an archeological survey. If archeological resources are encountered, appropriate mitigative actions - e. g. preservation, salvage - will be taken. Revetments are constructed on areas of the shoreline where problems with bankline stability have been encountered. While the preservation actions with regard to archeological resources are being taken, in the absence of such protective measures as revetments, the shoreline and any archaeological site contained therein would be expected to erode away. Since the erosion action of the river on the riverbank is a natural and continuous process, the question of the impact of revetments in shoreline archeological sites is problematic at best.

On the Lower Illinois River however, dredged materials are placed on bank. In this case archaeological resources located near the river could be covered by these materials. A comprehensive shoreline archeological survey along the 80 miles of the Lower Illinois is currently underway. Results of the survey will be reported in a later document; information on site locations derived will be used in planning dredge material placement locations.

If unrecorded archeological or historical sites are encountered during operation and maintenance precedures, work in the area that has the potential for adversely affecting the resource, will be halted until a determination of significance can be made by professional archeologists or historians. Appropriate measures would be taken to preserve site or mitigate adverse impacts on these resources in the event significant sites were located.

4.6.2 HISTORY

No historical sites will be disturbed by operation and maintenance activities.

No sites on the National Register of Historic Places will be affected by the continued operation and maintenance of the 9-foot channel.

PART 5

5. ADVERSE ENVIRONMENTAL EFFECTS WHICH CANNOT BE AVOIDED

5.1 GENERAL

Impacts which are truly unavoidable should the project continue in its present state would be the direct impacts of pool operation, channel maintenance dredging and revetment of shorelines. The impact of dredge material placement may be mitigated by proper planning and a series of alternatives different from the "least cost" method of disposal.

5.2 ADVERSE IMPACTS RESULTING FROM THE PROJECT

5.2.1 IMPACT TO RIVER REGIME

The development of pool conditions on the rivers has changed the "natural" river regime considerably. In section 4.1.1 the impacts were discussed at length. The following are summaries of the unavoidable adverse impacts that occurred to the "natural" river:

(1) The operation of the pools has caused a sequence of degradations and aggradations of the riverbed which probably would not have occurred in the same geographical positions in the natural river.

(2) Many of the tributaries on the floodplain have aggraded as a result of man's use of the land and the increased low flow stages in the navigation pools.

(3) Maintenance dredging creates "new" shoals adjacent to the thalweg. These sandbars are not permanent.

5.2.2 WATER QUALITY

In areas where dikes and revetments increase velocities of flow, the sediment transport capacity of the river will be increased also. If this occurs, the river bottom is further degraded, which puts into and keeps in suspension sediments and chemical constituents of the sediments, such as metals and pesticides.

Increased turbidity along with increased sedimentation are probably the most detrimental factors associated with maintenance dredging. Chemical constituents of the sediments, such as pesticides, metals, sulfides, methane, oil and grease, ammonia, or other substances, if present, can also be released to the water column by resuspension of the sediment or from runoff from land disposal areas. Resuspension of organic material and nutrients could also occur from the sediments. The organic matter could cause increased chemical oxygen demand in the water and the resulting decomposition could cause a reduction in dissolved oxygen concentrations if it remains suspended long enough to have a significant effect. The release of nutrients in the water column during dredging and the subsequent potential enhancement of eutrophic conditions has also been a major environmental concern. However, analysis of nutrients, heavy metals and other chemical constituents

in sediment samples collected from the main channel for the present study indicate that, for at least this pooled reach of the river, such impacts would be minimal. Generally, the effects of dredging on water quality appear to be localized and the affected water quality parameters return to their predredging status in a relatively short period of time.

In addition to the immediate turbidity generated during dredging, dredged material after placement is eroded to some extent by water. This affects areas that are situated close to the disposal site. Dredging near the entrances of side channels through which current flows may result in increased sedimentation rates caused from future wind and water erosion.

Operation and maintenance of the pool may reduce atmospheric reaeration by the reduction of turbulence and the decreased surface area/volume ratio. However, substantial improvements in dissolved oxygen concentrations are realized in the tailwaters downstream from the dams, sometimes for a considerable distance, because of the turbulence associated with water passage over the dam.

The operating machinery and gates of the locks and dams require periodic cleaning and lubrication of moving parts. Despite precautionary measures, lubricating materials could be spilled; the quanitites involved, however, are extremely small and have negligible effects downstream.

The potential always exists for accidental spills from barges and pipelines. Federal and State regulations prohibit the purposeful discharge of waste into the river, and such regulations greatly reduce the amount of waste entering the waterway. The greatest potential for accidental discharge of hazardous materials exists during the loading and unloading of barges, but occasional losses occur through barge wrecks or hard groundings and accidental pipeline breakages. The U.S. Coast Guard is responsible for measures to reduce the likelihood of spills and to minimize damage caused by spills that occur dispite preventive measures.

5.2.3 AQUATIC COMMUNITIES

Some aquatic habitat will be destroyed during dike, revetment, and lock and dam repairs. Disposal of dredged material in river border areas and dike fields could result in the smothering of benthic organisms, destruction of spawning areas for fish, reduction of habitat diversity and reduction of vegetative cover. Natural deposition of sediments in slack-water areas such as side channels and dike fields could result in a reduction of habitat diversity.

Most of the adverse impacts associated with operation and maintenance of the project are felt most acutely within the main channel habitat. These effects include dredging, placement of dredged material, and constriction of the river by dikes and revetments. All of these activities temporarily resuspend bottom sediments, thereby increasing turbidity and reducing light penetration, with the ultimate consequences being interference with primary production, flocculation of planktonic organisms, a decrease in food availability for fish, interference with the gills of fish, abrasion of benthic organisms in turbulent areas, and production of some effects that may be aesthetically displeasing.

Construction of the locks and dams may have adversely affected a number of individual species of fish by inhibiting their natural migration for spawning or other life-supporting purposes.

5.2.4 TERRESTRIAL COMMUNITIES

Since construction of the navigation dams in the 1940's, the flora and fauna of the floodplain have adjusted to the changed environmental situation (i.e., free-flowing river vs. pools). Excluding a major effort to convert the unprotected floodplain to agricultural fields, the flora and fauna of the project area should remain relatively stable. Three major factors will affect the terrestrial communities: (1) barge traffic, which contributes to pollution and bank erosion, (2) dredged materials placed in such a way that they might drift into and block slough areas, and (3) overbank deposition of dredged materials.

Barge traffic is expected to increase or maintain the current levels of pollution and bank erosion. The construction of revetments and the overbank deposition of dredged materials will destroy vegetation on or near the river bank. If deposition takes place within the willow, or possibly the silver maple-cottonwood communities, as is probable, then little adverse impact is expected.

5.2.5 CULTURAL

5.2.5.1. SOCIO-ECONOMIC

As developed in Section 4.3 and 4.4 the project has no adverse impacts on the socio-economic elements of the environments, i.e., land use, demography, and economics.

5.2.5.2 ARCHAEOLOGY

Until a comprehensive shoreline archaeological survey along the 80 miles of the lower Illinois River is completed, the impact of in-bank placement of dredged material on sites is unknown. No other phases of the action are deemed to be adverse to archaeological resources.

5.2.5.3 HISTORY

No historical sites will be adversely impacted by the project actions.

PART 6

6. ALTERNATIVES TO THE ACTION

Three categories of alternative plans of action are addressed in this part of the environmental statement: (1) cease all operations and maintenance; (2) selective placement of dredge material and; (3) change pool operations. These alternatives are discussed on the basis of their ability to provide the public with a reasonable method for fulfilling the authorized purpose of maintaining a nine-foot navigation channel in pools 24, 25, and 26 while also minimizing environmental impacts.

6.1. CEASE ALL OPERATIONS AND MAINTENANCE

6.1.1 GENERAL

Ceasing the operation and maintenance activities associated with the nine-foot navigation channel project would consist principally of cessation of all the activities described in Section 1 of this Environmental Statement. With discontinuation of funding for operation and maintenance of the project, the structures would have to be either eliminated or fixed in such a manner so as not to constitute a hazard to public health, safety, and well-being. Without maintenance the structure would eventually fail due to non-repair. Dredging of the Navigation channel would cease.

Implementation of this alternative would have several dramatic effects, principally to the socio-economic status of the regional economy and to the natural environment of the Mississippi River valley. Commercial navigation would be greatly reduced on the river with the main channel depths becoming unreliable, especially during the lower flow periods of the year. Attempts at commercial navigation would probably be limited to the high water periods, and even then an uncertain depth would limit the profitability of such use. The potential for increased accidents and grounding of vessels using the river in this condition would exist, as would the potential for an increase in spills of oil and other hazardous substances due to these accidents. If barge traffic were to cease, these potential groundings, accidents, and spills would also cease. There would be a transfer of shipment of the commodities currently carried by barge traffic to other modes of transportation. Initially there would be severe shortages of facilities to accommodate the large amount of freight currently handled by the waterway, however, as the alternate modes of transportation increased their handling capabilities, these shortages of facilities would be eliminated. There would no longer be the need of an annual expense to operate and maintain the waterway within the St. Louis District. There would be lost investments to firms with facilities located to best utilize the transportation and shipping opportunities provided by the navigation channel. Additional cost would be incurred to remove or modify the structures, and there would also be lost

investments in the project structures and other facilities associated with operation and maintenance of the project. Recreational use opportunities would be reduced along the river due to the decrease in water surface area, as well as recreation facilities associated with the project.

The long-term effect of discontinuing all operation and maintenance activities would be that the river would return to a "near" natural state. During months of heavy precipitation and runoff, conditions would be similar to those prevailing today. In late summer and winter months, when precipitation and runoff decreases, many of the highly productive backwater areas that serve as habitat and spawning areas for aquatic organisms as well as a stopover place for migratory water fowl would dry up.

Dredging and placement activities would no longer be practiced. The adverse impacts associated with actual placement activities would no longer exist. Further habitat destruction, creation of additional backwater areas, drainage pattern disruption, and exchange of chemical constituents from dredged materials would be avoided. The adverse effects of dredging activities not directly related to dredged material would be eliminated. This would include temporary increases in turbidity in dredge cut areas and destruction of benthic habitat in dredge cuts.

No new dikes have been constructed since the 1930's in the project area. As it would take a considerable time for the rock dikes to deteriorate to a point where they would no longer be effective water control structures, a halt to dike maintenance would have no impact on terrestrial fauna.

Considering the large amount of bank revetment already present in the project area, the cessation of its placement would probably make little difference to the area as a whole.

Without pool regulation, during dry summer periods parts of the river would be dry or extremely shallow. Some wetlands would begin to dry and revert to forest. However, the sandbanks built up in the river may change the river course as to create new side channels and wetlands or the banks may become vegetated and form new islands. During continuous low-flow periods, the unprotected floodplain may become susceptible to clearing and farming. However, unlike the middle Mississippi River where land ownership is mostly private, much of the unprotected floodplain in the project area is owned by federal or state conservation agencies, and hence, the amount of land leased to farmers could be regulated to maintain ecological diversity.

Elimination of dredging would reduce the rate of replacement of valuable wildlife habitat with sandy bedload sediment, some of which is currently attributable to maintenance dredging activities. Implementation of this alternative would require a major change in the primary objectives of the project and would have such a great impact on the present socio-economic and environmental setting that it could be considered a socially highly undesirable alternative.

6.1.2. SOCIO-ECONOMIC IMPACTS

6.1.2.1 Demography

The discontinuation of the operation and maintenance of those activities involved in sustaining the nine-foot channel, i.e., revetments, dikes, and dredging, would have no direct impact on the population. However, cessation of the product of the regulating works, i.e., the nine-foot navigable channel, would have an effect on the settlement pattern. This impact would take place at transportation termini, such as Alton, Louisiana, and Meredosia. These river towns not only were founded because of river access, but continue to utilize the waterway. The comparative advantage afforded these communities by the presence of the waterway has attracted economic activities, that, in the absence of the waterway might have located elsewhere. Cessation of the nine-foot channel would probably adversely effect the survival of these activities at their present location. Any impact on these industries could in turn be reflected in the population numbers and location.

6.1.2.2 National Economy

Non-maintenance of a nine-foot channel in the project reach would have substantial adverse impacts on the national economy. As had been noted above, this stretch of the river serves as a vital link between the Upper Mississippi, Illinois, and Missouri Rivers to the north, and the Ohio and Lower Mississippi Rivers to the south, with more than 88 percent of the total tonnage through the reach neither originating nor ending there. Breakage of this link would vastly change the current modal split. The very substantial tonnage moving between the two systems via this part of the river would have to be diverted to other modes of transportation.

Other major commodity flows would also be expected to be disrupted; for example, the movement of coal and chemicals from the Ohio to the Upper River.

While short run traffic for the railroads, and other modes of transport would exceed the ability of those modes to handle it, substantial excess capacity might be expected to

develop on other portions of the inland water system. Due to cleavage of the system into two smaller systems, both federally maintained navigation facilities and privately owned tows and barges would be underutilized, resulting in considerable economic waste.

6.1.2.3 Regional Economy

Discontinuation of operation and maintenance of this portion of the river would have varying impacts on different parts of the region.

A major position of commodities shipped in the waterway originating in the project area are grains. Substantial transportation savings to shippers are realized using the waterway. These savings represent increased revenue that can be used in other ways. A discontinuation of waterway service would force the utilization of other costlier modes of transportation. Higher shipping costs would decrease from revenues and would represent a negative impact on farming operations, particularly on marginal operations.

Commodities brought into the area include coal and petroleum products. These materials are used primarily for electrical power generation. In a condition where the nine-foot channel was inoperable, these materials would have to move via other transportation modes. In such a situation increased transportation rates would be passed on to consumers in the form of higher electrical utility rates.

6.1.2.4 Land Use

Cessation of operation and maintenance of the nine-foot channel and the subsequent loss of the navigable channel would impact the location and extent of urban land use. As pointed out in Section 2.3, the comparative advantage afforded the river towns of Alton, Louisiana, and Meredosia, by the presence of the waterway has attracted economic activities, that, in the absence of the waterway might have located elsewhere. The discontinuance of the nine-foot channel would probably adversely effect the survival of these activities at their present location. Any impact on these industries would in turn be reflected in the population as well as the land use. Should industries in the study area perceive that they cannot economically survive without the comparative advantage afforded by the waterway, and thus subsequently relocate out of the study area, the extent of urban land use would be reduced. This reduction would initially take place in industrial land and in time have an effect on reducing residential and commercial land. Most of this reduction of urban land would take place at the river towns of Alton, Louisiana, and Meredosia.

6.2 SELECTIVE PLACEMENT OF DREDGE MATERIAL

6.2.1 OPEN WATER PLACEMENT, SELECTIVE PLACEMENT

Selective placement of dredge material consists of placement areas near the dredge cut. This alternative is currently utilized as the principal method for dredge material placement in Pools 24, 25, and 26. Placement sites are selected after specific dredge cuts are identified and the volume of material to be removed is calculated. In many instances the placement sites are located adjacent to the dredge cut becuase of the nature of the cut; i.e., a dredge cut 5,000 feet in length. If these dredge cuts have a greater length than the dredge plant capabilities to transport the material, then sites must be selected on the basis of plant capabilities. This method may be referred to as the "least-cost" method of dredge material placement. The entire procedure of selective placement actively involves ongoing coordination with respective State and Federal agencies to determine the probable impact of dredge material placement.

The possibility exists for selective placement of dredge material at distances greater than those which are possible with present dredge plant capabilities. The following is a summary of estimated cost data if additional pipeline equipment were available for the dredges Kennedy and Ste. Genevieve: (1) An additional 1,000 feet of floating pipeline would increase the transport capabilities of the Kennedy to 1,900 feet. This would require an estimated $977,000 worth of additional equipment including a tender, pipe, floats, walkway and related equipment. Additional annual operating costs are estimated to be $432,000. This would increase the cost of moving a cubic yard of dredge material approximately 25 cents for a total of 95 cents. It should be noted that production increases because the dredge would not have to be repositioned as often. (2) An additional 5,000 feet of floating pipeline would increase the transport capabilities of the Dredge Ste. Genevieve to 8,000 feet. This would require an estimated $4.5 million worth of additional equipment, including two tenders, pipe, floats, walkway and related equipment. Additional annual operating costs are estimated to be approximately $1.8 million. This would increase the cost of moving a cubic yard of dredge material approximately 60 cents for a total of $1.00/cubic yard. Also, it should be noted that production increases because the dredge would not have to be repositioned as often.

The possibility exists to use selective placement sites which are several miles from the desired dredge cut if adequate financial resources were available. This concept needs further study to determine the viability of expanding this method of dredge material placement.

In open water placement the dredged material generated is deposited alongside the channel in the river border areas. Some short-term effects associated with placement operations include: (a) Increased turbidity reduces light penetration, and, therefore, may interfere with primary production, flocculate plankton organism, decrease food availability, cause changes in temperature patterns, cause a shift from game fish to rough fish, and produce effects that are aesthetically displeasing (b) Increased sedimentation that could result in the smothering of benthic organisms, destruction of spawning areas for fish, reduced habitat diversity, and reduced vegetation cover; (c) Reduction of dissolved oxygen concentration that could suffocate or stress organisms in the immediate vicinity and/or release noxious materials, such as sulfides, methane, and heavy metals, into the water column.

Unlike short-term effects, which usually can be detected during or immediately after the disposal operation, long-term effects can be more subtle and thus more difficult to detect and evaluate. The possibility of long-term effects as a result of disposal operations is attributed to the presence of nutrients and chemical toxins in the sediment and their release and subsequent effect on the extent, rate, and diversity of the recolonization of benthic populations.

The placement of dredged materials in critical areas, such as areas near the entrances or exits of side channels, may have deleterious effects. The direct placement of dredged material in these locations could block the flow of water through the side channels and thereby prevent the movement of fish between side channel and river; could reduce the flow and consequently alter existing physicochemical characteristics; etc. Consequently placement in these areas is being avoided.

6.2.2 THALWEG PLACEMENT

The thalweg is the deepest section of the channel which must be maintained at critical crossings in the river system. These crossings which tend to silt up are identified in Plate 9. Engineers at Colorado State University have developed a mathematical model of the river system in which the consequences of midchannel disposal of dredge material immediately downstream of critical crossings may be predicted. It is important to remember that the thalweg is the most sterile (biologically) portion of the river system in that the deep channel contains a naturally shifting bed load of sands.

In Pool 25, one crossing that has required extensive dredging and the pool immediately downstream were identified and modelled. An imaginary dredge cut three feet deep and 950 feet

long (from river mile 268.91 to 268.72) was made in the crossing area over the channel width. The cut was made at the beginning of the low-water season and the riverbed level changes in the modelled reach were computed during the next year for the two-year annual hydrograph.

These riverbed levels were compared with those that would occur during the same year if no dredge cut were made. Without dredging, the crossing aggrades and the pool area degrades. With dredging and placement of the dredge material downstream in the pool area, the dredge cut is filled in and the placement bar is eroded away within a year. That is, after one year both the critical crossing and the pool are back to the natural state. This result is supported by field experience and explains why many river reaches require repeated dredging.

If the dredged material is placed in the downsteam pool area, the disposed bar is generally eroded away within a year unless the next hydrograph following the dredging is uncommonly small. If the hydrograph is small, the disposed material may accumulate in the crossing downstream of the placement area in the pool without much attenuation of bar height. This could introduce new dredging problems in the downstream river system.

In thalweg placement, the dredged material is deposited back into the main channel in the downstream pool. This will still resuspend sediments causing a temporary and local increase in turbidity. However, with this alternative all impacts will mostly be confined to the main channel where the sediments are continually being deposited and resuspended, thus allowing very little time for build-up of pollutants. This naturally shifting substrate along with the greater current velocity also causes the main channel to provide very poor habitat resulting in little potential for serious biological impact. This activity would have no effect on terrestrial vertebrates.

The mathematical modeling of a particularly troublesome reach of Pool 25 on the Upper Mississippi indicates that dredging from a crossing and placing the dredged material in a downstream pool does constitute a feasible dredge placement method. The process incolves a degree of risk to the navigation channel downstream from the pool, particularly if dredging is followed by a small discharge hydrograph. However, at many locations the risks incurred by thalweg placement would be outweighed by the potential environmental benefits of avoiding bankline placement. In addition, any serious ecological problems associated with open water placement on marshlands and near chute channels, sloughs, and backwater areas are avoided by placing dredged materials in the thalweg. Although conditions downstream of a proposed placement site may preclude thalweg placement at certain locations, in many cases placing only a portion of the dredged material along the thalweg would still result in reduced environmental impacts. Consequently, the concept of thalweg placement offers a viable alternative to both long-term and emergency placement requirements. The results of this limited study are sufficiently promising to warrant additional investigation of the concept of thalweg placement of dredged material.

6.2.3 RECREATIONAL POTENTIAL

Periodically, dredge material has been utilized for recreational activities within pools 24, 25, and 26. The Corps of Engineers has placed material, upon request from private citizens and public agencies, at various points along the Illinois and Mississippi Rivers. Dredge material tends to attract people because of its sandy nature. The potential for utilizing dredge material for recreational beaches appears to present opportunities for a program of dredge material placement for recreational potential.

For example, in 1973, approximately 300,000 cubic yards of material was dredged from the main channel at rivermile 222-224. This material, being rich in sand was placed at Royal Landing to stabilize the bank and improve the physical qualities of the beach. It has been reported that during the summer months this facility is used beyond its intended capacity.

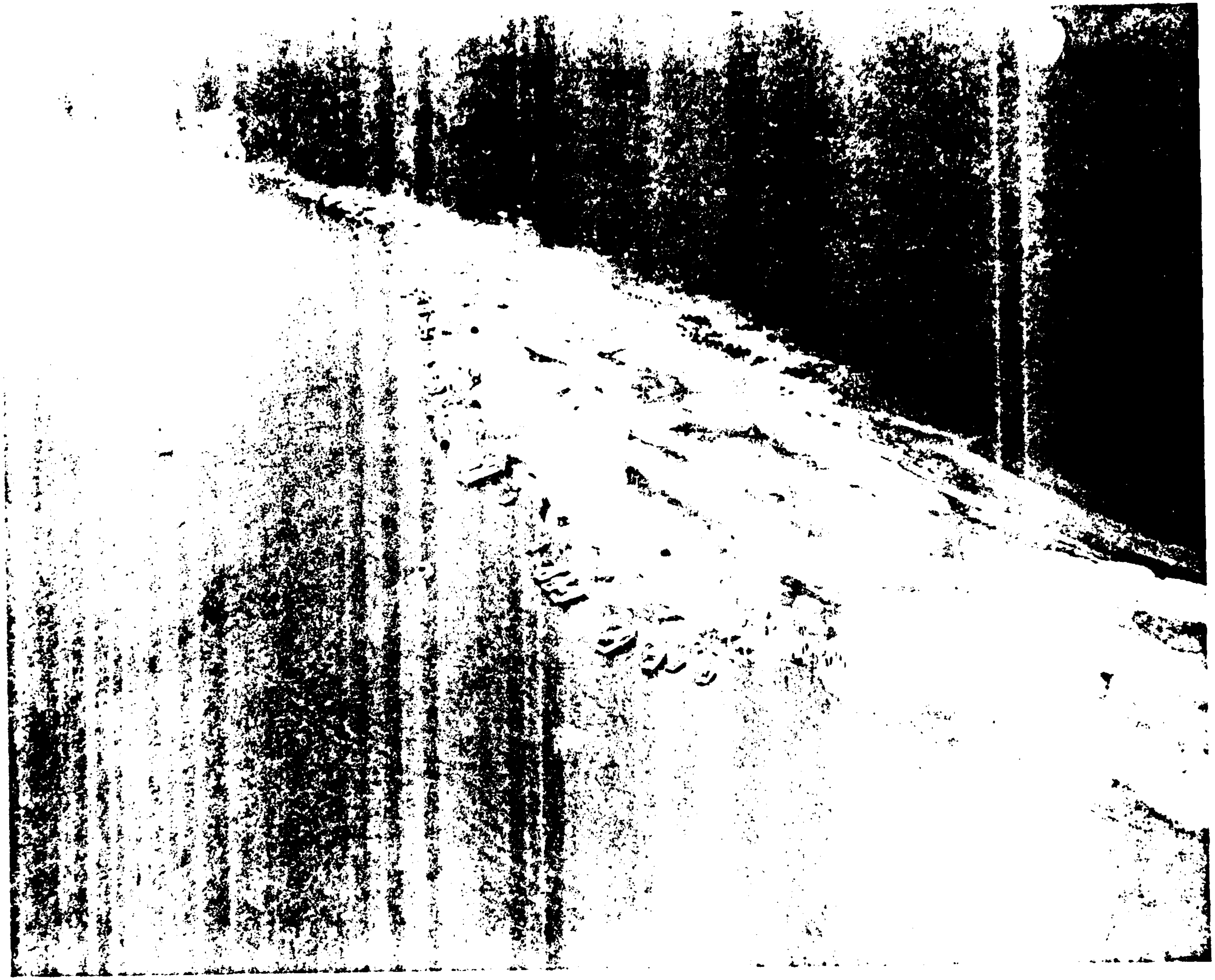
To better document the use of dredge material by recreational boaters, an aerial survey was conducted of the study area on July 5, 1975. Figures 6-1 and 6-2 illustrate the utilization of dredge material placement sites by recreational boaters in Pool 26, Mississippi River. Figure 6-1 is located at river mile 225.0 at the upstream end of Iowa Island, Missouri side of the navigation channel.

A study in which field surveys were conducted in August 1975, showed that the public awareness of the Corps of Engineers dredging of the navigation channel and subsequent creation of sandy beaches resulting from the placement of dredge material was extremely high (Bach, 1975). A majority of those surveyed thought that utilizing dredge material for beach nourishment is a desirable practice.

Previously, these kinds of efforts have been largely accomplished on an informal and uncoordinated basis. With proper research and planning, it is felt that dredge material can be utilized as a resource for creating and improving the recreational potential of Pools 24, 25 and 26. This area of recreational potential for dredge material warrants a more comprehensive study in which the parameters of dredge material utilization for recreational purposes are clearly outlined.

The effect on aquatic communities of the use of dredged material to develop recreational areas will depend on the location of such areas. The provision of sanitary facilities and the trash and litter disposal would remove a source of water pollution and improve the overall aesthetic setting. Sanitary facilities and water supply would have to be constructed consistent with public health codes and State regulations. Special provisions would be needed in areas subject to inundation by high water levels.

Any site developed for human use will usually not be attractive to most forms of wildlife. At night rodents, raccoons, and opossums will utilize garbage cans and dumps. Beaches created with dredged material may attract shorebirds, gulls, and crows.



G-1 Dredge Material Beach River Mile 222.5 Royal Landing

G-2 Dredge Material Beach River Mile 225 Iowa Island

Figure 6.3

DISCHARGE RANGE MODEL

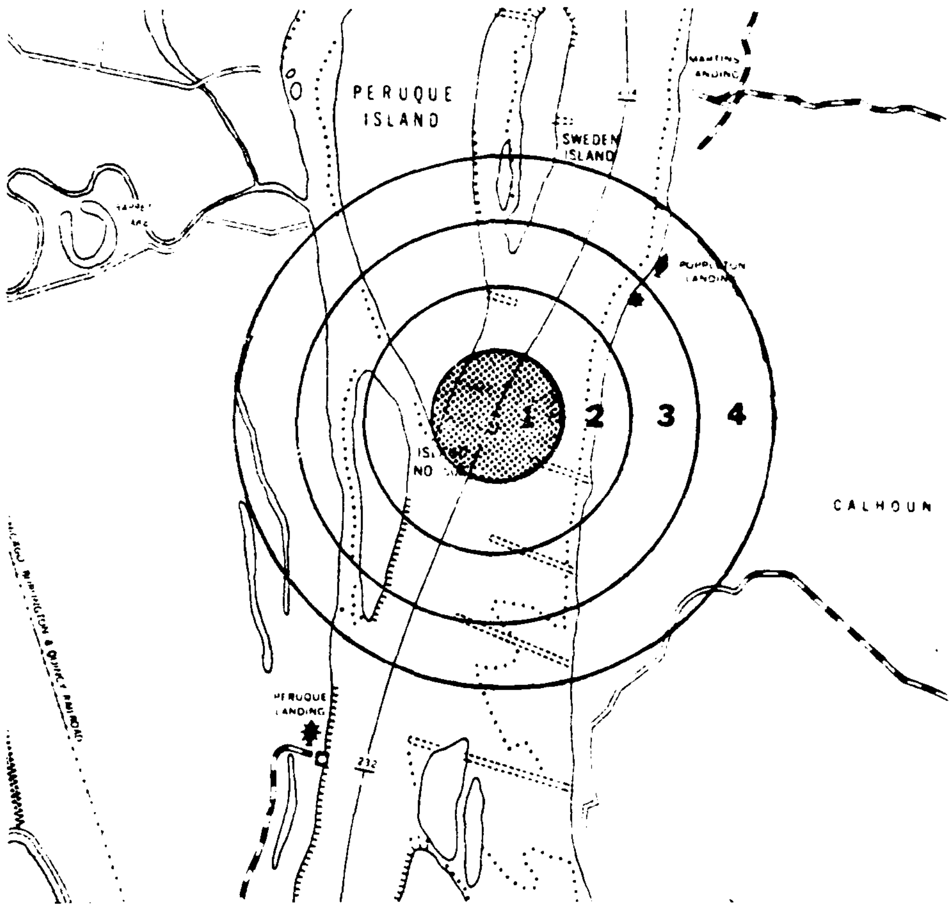


Figure 6.3 is a preliminary illustration of how increasing discharge range becomes a function of increased costs. The present optimum discharge range (950 feet) of the dredge Kennedy is shown as a shaded circle. If the discharge range were to be increased to 1500 feet (2nd circle), a one time expenditure of $880,000 would be required to achieve this range. Likewise, to increase the discharge range to 2000 feet and 2500 feet a one time expenditure of $1,410,000 and $2,090,000 would be required respectively. These ranges are represented by circles 3 and 4. The cost data presented above are approximate extimates and need further study to determine the feasibility of increasing the discharge range of the dredge Kennedy.

6.2.4 STOCKPILING DREDGE MATERIAL

The stockpiling of dredge material for commercial utilization for such items as fill material, mortar sand, aggregate, concrete and other uses depends on many factors. Included in these factors are such things as the physical suitability of the material, the economics of handling it, including the location from where it is being dredged compared to its eventual point of use and the demand for its use.

Such commercial use offers the benefit of reducing the extent in which the aquatic and terrestrial ecosystems are disrupted and at the same time provides a benefit use for the material being disposed of. Placement of dredged material for commercial purposes would require quite different dredged material placement practices. As such, many of the adverse impacts associated with current practices could probably be reduced.

Economic processes may be disrupted by providing material to areas which do not normally have this material available, as well as market values for the uses employed may suffer declines. The economic impact would probably be felt primarily by private dredge contractors and sand and gravel companies which might lose business because of a change in market conditions.

This would have little impact on the aquatic communities except in the actual area of the dredge cut, where there would be direct disturbance of the substrate and a temporary increase in turbidity. Since dredging takes place in the biologically less productive main channel it would have little effect. If the dredged material were contaminated with excessive nutrients or other pollutants it would be possible that runoff from the stockpile area could cause a water quality problem.

The effect of this activity on wildlife would depend on the site chosen. As such an operation would destroy everything on the chosen site, a complete environmental analysis would have to be conducted.

6.2.5 OVERBANK PLACEMENT

The practice of overbank placement of dredge material occurs in the Illinois River on a limited basis. When dredging is performed during a high river stage, overbank placement is often accomplished because: (1) it falls within the least cost method of dredge material placement and (2) provides the best physical alternative for dredge material placement at the time. The ramifications of overbank placement need to be thoroughly examined as to the biological impacts which may result due to this type of placement. Again, coordination is maintained with

respective state and federal agencies so as to determine probable impacts connected with this alternate method of placement.

Little impact on aquatic communities will result from this method of placement except in the biologically less productive main channel where the actual dredging occurs. Runoff during placement and rain storms and inundation during periods of high water could eventually wash material back into the river. The problems that this could generate include excessive turbidity and siltation, possible release of toxicants, and dissolved oxygen depletion due to release or organics.

Dredged material placed on land, especially on riverbanks, can temporarily or permanently eliminate the vegetation, bank dwelling mammals, and amphibians. If the material is sand, turtles may use it as spawning sites. Revegetation of placement sites will occur; 25 percent plant cover was achieved within five years on one placement site along the Mississippi River (Missouri Botanical Gardens 1975).

6.2.6 SEDIMENTATION CONTROL

Sedimentation control within the watersheds would reduce sediment loads in tributary streams. It may be noted that channelization of tributaries, upland agricultural and urban activities deliver sediment to the major rivers which, because of their development, may or may not be competent to move these sediments out of the area. Therefore, sedimentation control should be analyzed in terms of man's use of the land in order to adequately identify those areas of sediment contribution.

This would reduce the amount of maintenance dredging needed for the navigation system, and, in turn, would reduce the adverse environmental impacts associated with dredging. Watershed land treatment might also result in a reduction in natural sedimentation, particularly in biologically-sensitive backwater areas of the navigation pools.

6.2.7 REMOVAL FROM THE FLOODPLAIN

The removal of dredge material from the floodplain is an alternative which is closely related to the "Stockpiling of Dredge Material" alternative. Considerable study needs to be accomplished to determine what combination of dredge plant capabilities and overland transport options are available to move dredge material from the floodplain. Also, detailed cost information needs to be constructed to provide the measure of economic feasibility required to adequately analyze this alternative.

This method will result in little physical disruption of the aquatic systems. However, water quality problems would arise during dewatering operations while scows were loaded.

Release of toxicants, suspended solids, and oxygen-demanding materials could occur. Also runoff from the placement locations outside the flood plain could affect the aquatic environment of the drainage basin in which the material is placed.

The effects on the natural river ecosystems from moving the dredged material out of the flood plain could be important. The rate of total sediment accumulation in the navigation pools would be reduced from present rates. The effects on aquatic ecosystems due to the placement or indirect movement of dredged material deposits would be reduced; however, the loss of backwater areas due to the accumulation of sediments that are not being dredged would continue as under present conditions. The biological life of the navigation pools may not be significantly affected by removing the dredged material from the flood plain if the natural phenomenon of backwater areas being filled with sediments other than dredged material is the overriding influence.

6.3 POOL OPERATIONS

6.3.1 GENERAL

To accomplish the 9-foot channel in the Upper Mississippi, the construction of a system of navigation locks and dams was authorized in 1930, and expanded in 1932, 1935, 1937, 1945 and 1958. These locks and dams, supplemented by dredging, achieve the 9-foot depth during all seasons of the year. Locks and dams at Alton, Illinois, Winfield and Clarksville, Missouri, (Pools No. 26, 25, and 24) create pooled conditions on 98.3 miles of the Mississippi River within the St. Louis District. In addition, the Locks and Dam at Alton, Illinois, create a pooled condition on the lower 80 miles of the Illinois River.

6.3.2 EFFECT OF POOL FLUCTUATIONS ON RIVER MORPHOLOGY

The geomorphic changes in the study reach caused by holding the pool level one foot above the normal pool level for 50 years are not significantly different from operation at normal pool level. The geomorphic changes of these two systems are similar. However, increasing the pool level reduces the sediment transport capability of the river reach. The reach aggrades more and degrades less when the pool is held one foot higher than normal pool. The maximum difference is on the order of 1.0 foot in the degrading reach immediately below Lock and Dam 24.

There would be a 10 percent increase (according to the math model) in floodplain deposits of silts and clays resulting from holding the normal pool level one foot higher but as these floodplain deposits are very small, the increase is of no significance. The natural levee heights are not increased significantly either.

The effects of holding the pool level one foot below the normal pool level on the geomorphic changes are not much different than for 50 years of operation at normal pool. The trends of the changes are similar but decreasing the pool level increases the transport capacity so that there is less aggradation and more degradation with the lower pool. The maximum difference in riverbed levels is 0.7 foot in the degrading reach immediately below Lock and Dam 24.

The effect of operation at lower than normal pool for 50 years is that floodplain deposits are less but this is not an important factor.

It is then clear that by changing the operation scheme for the locks and dams to raise or lower the normal pool level by one foot has limited effects on the morphology of the river and adjacent lands.

6.3.3 EFFECT OF POOL FLUCTUATIONS ON FISH AND WILDLIFE

Management of water levels in various pools would be desirable to facilitate management of fish and wildlife resources. A system of controlled manipulation of water levels within an aquatic-terrestrial ecosystem provides the controller with an important tool with which the relative abundance of habitat types can be varied.

The individual pools are variable in the proportion of terrestrial habitat, marsh habitat, and deep water habitat. However, the pools in general can be divided into three distinct categories: headwaters, mid-pool, and the open, deep water section immediately above the lock and dam. Deep sloughs and wooded islands are generally found in the headwater area with little or no marsh habitat developed. The central area of the pool usually contains both the maximum proportion of marsh development and an abundance of aquatic habitat. Within the lower end of the pool the water is open and deep and, while substantial aquatic vegetation may occur, there is practically no marsh development.

Within the scope of this report, it would be impractical to attempt an evaluation of all impacts of the numerous possible variations in water level manipulation methodology. Therefore, only two generalized examples will be discussed, a temporary pool raise and a winter drawdown.

In general, the utilization of controlled water level raises would be for the purpose of thinning out expansive dense stands of emergent or submergent aquatic vegetation. Solid stands of emergents in a marsh are not generally desirable. Most wildlife in a marsh prefer the "edge effect," or interspersion of various types of vegetation. When dense, solid stands of emergents do occur, water level raises may provide a means of changing the stands and creating the interspersion desirable in habitat

management. The thinning out of expansive stands of submergent vegetation may or may not be desirable depending upon management objective. For example, thinning dense stands of submergent vegetation would increase boating accessibility into these areas thereby increasing recreation potential. However, some species of submergents are valuable food sources for waterfowl during fall migrations. Water level raises could interfere with the availability of this food source to migrating waterfowl. The thinning of aquatic vegetation in areas which are subjected to strong currents or winds could also generate turbidity which could be detrimental to game fish, to the remaining vegetation, and to water quality.

Stabilized water levels during the growing season sometimes are preferable when production of desired species of submergent aquatic vegetation is the management objective. However, impoundments that have been held at stable levels for too long can build up an accumulation of undecayed plant material. Under such conditions there is often a decline in the production of desired species of aquatic plants. Drawdowns permit the aeration of bottom sediments thereby stimulating decomposition and releasing nutrients that are bound up in undecayed plant material. Organic decomposition also retards the gradual filling of shallow impoundments by the accumulation of aquatic vegetation. Drawdowns can be important in improving production of valuable submergent aquatic plants such as sago pondweed or valuable emergents such as the smartweeds.

A winter drawdown would probably create adverse conditions for many fish species and muskrats. In general, panfish and roughfish should be affected the most because these fish inhabit the shallow backwaters, ponds, and sloughs where winter kill conditions would be the greatest. Walleyes and other fish inhabiting the tailwaters, side channel, and main channel borders would not be greatly affected by a winter drawdown. It might be possible to reduce the potential winter kill to fish by lowering water levels slowly and by deepening backwater channels allowing the fish to escape into deeper water. A winter drawdown would probably greatly reduce the muskrat population of the affected pool. This impact could not be offset, but a managed increase in trapping pressure in pools planned for winter drawdown might reduce the winter loss of animals. Recreational and commercial fishing activities would probably be adversely affected by winter drawdown. However, winter drawdown in some cases might have a concentrating effect on commercial fish species.

The application of any water level fluctuation management which would benefit fish and wildlife resources would also benefit the consumptive and non-consumptive recreational uses of those resources. Recreational boaters would probably benefit from measures that would expand accessibility in the guts, chutes, side channels, and backwater areas.

PART 7

7. THE RELATIONSHIP BETWEEN LOCAL SHORT-TERM USES OF MAN'S ENVIRONMENT AND THE MAINTENANCE AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY

The continued operation and maintenance of the 9-foot navigation channel contributes to the long-term economic productivity of the area by permitting the economic advantages of low-cost waterborne transportation. The efficiency of waterborne transportation will probably foster the continued or expanded economic development of cities and industry along the Upper Mississippi River. The 9-foot channel project, which committed the use of land and water resources of the Mississippi River valley, was not conceived as a short-term use of these resources in man's environment. The perpetuation of water transportation was envisioned as providing long-term social and economic productivity within the human environment.

The operation of the pools has changed the character of the river with an increase in water surface area, number of islands and number of side channels. The high biological activity of the additional side channels and chutes has been further enhanced by the control of low water conditions.

The permanent pools have an effect on fish populations. As an example, construction of the locks and dams reduced the numbers of fish species that normally migrate up and down the river or prefer swift moving water and rapids. Other fish species have increased due to the expanded river, lakes, pools, and marshes. Generally, most fish populations have increased as a result of the permanent pools. Continued operation of the locks and dams would perpetuate their changes in fish species and population levels.

Fish, wildlife, and recreation interests are deeply concerned about the possible implication of eroded dredge spoil in the blockage of the entrances of flowing sloughs. The fish and wildlife interests have pointed out that extensive shallow aquatic backwater habitats depend upon flowing sloughs for supplies of fresh, oxygenated water and for the flushing of dissolved nutrients. Without the freshening and flushing, backwater systems tend to stagnate. This reduces the production of desirable sport fish, the potential for use by migrating water-fowl, the production of food and house-building materials for furbearing semiaquatic mammals, and the quality of the aesthetic setting. Recreation boaters have noted also that the blockage of the sloughs reduces boating access.

Recently, increased attention has been given to the role of sediment as a carrier of plant nutrients, pesticides and toxic elements. Research indicates that clay minerals such as those found in river sediment have active surfaces that react with an array of chemical compounds. These compounds may be concentrated in the sediment

over a period of years and then redistributed during a high-flow period. Plant nutrients such as nitrogen, phosphorous, potassium, and certain trace elements (micronutrients) are absorbed on sediments and may have biological significance in the eutrophication of ponds, reservoirs and lakes.

Continued sedimentation of side-channels is threatening the biological productivity of these areas. Most of this closure is a natural process and it is not known how the lock and dams structures effect the movement of sand plugs down the chutes. Dredge material placement at the head of the side channels has been regulated since 1958 with the enactment of the Fish and Wildlife Coordination Act.

The present least-cost method of dredge material placement has resulted in losses of acreage of productive aquatic habitat, in particular benthic resources. Also, some terrestrial resource loss has resulted because of on-bank disposal along the Illinois River. Rate of recovery of these environments is dependent upon the conditions which exist after the disposal process and the frequency of disposal.

The proper placement of material has contributed to long-term recreational productivity. As population increased, recreational opportunities will become increasingly important.

PART 8

8. IRREVERSIBLE OR IRRETRIEVABLE COMMITMENTS OF RESOURCES

Operation and maintenance of the 9-foot channel will result in some irretrievable and irreversible commitments of economic and natural resources. Labor and materials are required to operate and maintain the locks and dams, to perform the dredging and disposal activities, and to administer the overall program.

Alterations of the "natural river" has occurred and may be considered a loss to future generations under present operation and maintenance procedures. Open-water and on-bank dredge material disposal results in irreversible losses and on occasion, where continued dredging occurs, irretrievable losses may result. Aquatic and floodplain plants and animals could be buried and smothered.

Development of commercial and industrial facilities along the rivers are indirectly encouraged by the maintenance of the river system which often leads to a further loss of water quality, habitat and lands dedicated to fish, wildlife and recreational uses.

A continued loss of side-channels created by the pools will result from natural causes and because of the operation and maintenance of the 9-foot channel.

PART 9

COORDINATION AND COMMENT AND RESPONSE

9. COORDINATION WITH OTHERS

9.1 FEDERAL AND STATE AGENCIES

The combined efforts of state and federal agencies were utilized, and their views were given careful consideration in the preparation of this environmental statement and the formulation of the associated studies, which were undertaken for the statement. The federal agencies which participated are:

U.S. Army Engineer Division, Lower Mississippi River Valley Vicksburg, Mississippi

U.S. Army Engineer District, St. Louis, St. Louis, Missouri

U.S. Army Engineer Waterways Experiment Station Vicksburg, Mississippi

U.S. Fish and Wildlife Service Department of the Interior Rock Island, Illinois

The state agencies which participated are:

The Missouri Department of Conservation

The State of Illinois, Department of Conservation

In addition, Southern Illinois University at Carbondale, Illinois, Natural History Survey, Colorado State University, Fort Collins, Colorado, Midwest Aquatic Institute, and Missouri Botanical Garden participated in this study program under separate contracts led by the Waterways Experiment Station (WES), Vicksburg, Mississippi, on behalf of the U.S. Army Engineer District, St. Louis, Missouri.

9.2 COORDINATION LEADING TO THE SUBSEQUENT PREPARATION OF THIS ENVIRONMENTAL IMPACT STATEMENT

Approximately 6,000 acres in Pools 24, 25, and 26 are managed under a General Plan (G.P.) as promugated under authority of the Fish and Wildlife Coordination Act, 1958. To implement the General Plan, Cooperative Agreements have been prepared with the U.S.Fish and Wildlife Service, Illinois Department of Conservation and the Missouri Conservation Commission. The U.S. Fish and Wildlife Service's Mark Twain National Wildlife Refuge is served by these cooperative agreements. Periodic meetings with these agencies are held, usually one or two times a year to review annual management plans, aspects of master planning and mutual problems that require solving. The Operations Division, the Planning Branch of the Engineer Division, and the Management and Disposal Branch of the Real Estate Division are usually involved in these coordination meetings.

The U.S. Dept. of Agriculture, Soil Conservation Service, through the Two Rivers Resource Conservation and Deveaopment Project which serves a five county area between the Mississippi and Illinois Rivers has recently become involved in wildlife conservation coordination meeting. This project leadership has established a wildlife committee of local citizens which draw upon a panel of fish and wildlife professionals from the Illinois Department of Conservation Service. The purpose of the Two Rivers Wildlife Committee is to develop and promote the enhancement of the fish and wildlife resources in this five county region.

Several sportsmen clubs have taken an active interest in the management of wildlife resources with the Navigation Pool areas. Leading these interests are the Migratory Waterfowl Hunters, Inc., Alton; Batchtown Sportsmen Club, Batchtown; and the Wood River Sportsmen Club of Wood River. Frequent meetings are held with these clubs, often with representatives of the U.S. Fish and Wildlife Service and the Illinois Department of Conservation attending, to review and discuss mutual problems and to seek means to improve wildlife management and habitat within the pools.

The Corps Master Plan governs the land use and development of Corps fee lands with the Navigation Pool areas. Revision of Master Plans are scheduled to begin in FY 76. Preliminary meetings which discussed Master Plan revision have been held with all of the agencies and sportsmen clubs listed above. Coordination meetings of this type will intensify as work progresses on Master Plan revision.

Coordination efforts leading to the subsequent preparation of this environmental impact statement are directly related to coordination efforts undertaken to prepare an environmental impact statement for the 9-foot channel project, middle Mississippi River between the mouth of the Ohio and Missouri Rivers. The draft of the environmental impact statement entitled "Mississippi River Between the Ohio and Missouri Rivers Regulating Works" was circulated for review during May 1975.

In the Draft Statement an error was made in discussing the problem of the building of new dikes; this is an element in the Middle River. Also, the post-authorization change discussed in the Middle River Environmental Statement was inadvertently included in the draft of the Upper River Statement. The reader should refer to the Statement of Findings to clarify the Corps position on the Upper River.

9.3 COMMENTS AND RESPONSES TO THE DRAFT ENVIRONMENTAL STATEMENT

The Draft Environmental Statement was sent to the following agencies, organizations and individuals. Those agencies and groups marked with an asterisk have responded.

*Environmental Protection Agency
*Advisory Council on Historic Preservation
*U.S. Forest Service
*U.S. Soil Conservation Service
U.S. Department of Commerce
*U.S. Department of Housing and Urban Development
*U.S. Department of the Interior
*Federal Highway Administration
*U.S. Department of Transportation
*U.S. Federal Power Commission
*U.S. Department of Health, Education, and Welfare
U.S. Senate
  U.S. Senators, Missouri
  U.S. Senators, Illinois
Governor of Illinois
Illinois Projects Task Force
*Illinois Archaeological Survey
*Illinois Department of Conservation
*Illinois State Geological Survey
Governor of Missouri
Missouri Department of Community Affairs
Boards of Supervisors, Counties of:
  Cass County, Illinois
  Morgan County, Illinois
  Scott County, Illinois
  Greene County, Illinois
  Jersey County, Illinois
  Brown County, Illinois
  Pike County, Illinois
  Calhoun County, Illinois
  Madison County, Illinois
  St. Clair County, Illinois
  Ralls County, Missouri
  Pike County, Missouri
  Lincoln County, Missouri
  St. Charles County, Missouri

St. Louis County, Missouri
Mayor of Alton, Illinois
Mayor of Hardin, Illinois
Mayor of Kampsville, Illinois
Mayor of Meredosia, Illinois
Mayor of Winfield, Missouri
Mayor of Elsberry, Missouri
Mayor of Clarksville, Missouri
Mayor of Louisiana, Missouri
East-West Gateway Coordinating Council
Southwestern Illinois Metropolitan Area Planning Commission
Southeast Missouri Regional Planning Commission
St. Louis Regional Commerce and Growth Association
Bi-State Development Agency
Mark Twain Regional Planning Commission
Boonslick Regional Planning Commission
Two Rivers R C & D Project
*Migratory Waterfowl Hunters, Inc.
Batchtown Sportsmen Club
Wood River Sportsmen Club
American Institute of Merchant Shipping
American Waterways Operators, Inc.
Western Railroad Association
Mobile Oil Corporation
Missouri Portland Cement
Vollmar Brothers Construction Company
N.L. Industries
Mid-America Transportation Company
*The Waterways Journal
Granite City Steel
Laclede Steel Company
Manufacturers Railway Company
Reitz & Jens, Inc.
Transportation Institute
The Pillsbury Company
Apex Marine Service, Inc.
River Cement
*The Ohio River Company
American Commercial Barge Line
*Wisconsin Barge Line
Mississippi River Transportation Corporation
The Valley Line Company
Warren & Von Pragg, Inc.
Riverside Sand and Dredging
American River Transportation
Federal Barge Lines
Agri-Trans Corporation
SN & NO Barge Line
Industrial Sugars, Inc.
Industrial Sugars-Borden, Inc.
*St. Louis Water Division
Dixie Dredge Corporation
Midwest Towing Company, Inc.
Gunther Salt Company
National Marine Service
St. Louis Terminal Corporation

Luhr Brothers, Inc.
Marine Officers Association
J. S. Alberici Constuction Company
Apex Oil Company
*Union Electric Co.
Coalition for the Environment
Environmental Defense Fund, Inc.
Environmental Response
The Coalition on American Rivers
American Fishery Society
    Illinois Chapter
    *Missouri Chapter
The Izaak Walton League, Inc.
Conservation Federal of Missouri
*Sierra Club
    Ozark Chapter
    *Piasa Palisades Group
    Shawnee Group, Great Lakes Chapter
The Wildlife Society
    Illinois Chapter
    Missouri Chapter
Audubon Society
    Illinois Chapter
    Missouri Chapter
Upper Mississippi River Conservation Committee
Missouri Natural Area Survey
Missouri Botanical Garden
*Missouri Archaeological Survey

a. ENVIRONMENTAL PROTECTION AGENCY REGION V (letter dated Sept. 11, 1975)

Comment 1: To demonstrate how the O&M program outlined in the EIS has minimized adverse environmental impacts which resulted from past dredging practices, the final EIS should compare and contrast past operation and maintenance activities with the proposed O&M program discussed in the EIS. Differences in past dredge spoil disposal activities to the proposed disposal program should be indicated.

Response: The operation and maintenance program has been discussed in sections 4.1.2, 5.2 and alternatives discussed in section 6.2. In plates 9A, B, C, D dredge activities were mapped from 1969 through 1974. Proposed dredging activities are outlined in the Statement of Findings.

Comment 2: It is noted that some wetland areas will be affected by the project. EPA's Wetlands Policy states that wetlands must be protected from adverse dredging and filling practices. Therefore, extreme care must be taken during O&M activities to avoid and minimize any adverse impact upon wetlands. The Corps of Engineers policy regarding the safeguard of wetlands is highly desirable and consistent with our own views. With responsive and expedient implementation, such policy will substantially discourage the unnecessary alteration and destruction of wetlands considered to be vital to the riverine flowage. Although this policy is directed primarily toward the evaluation of permit applications, we fully realize the inherent responsibility of the Corps in following the dictates of its own policy and the guidance of EPA and other agencies in wetland preservation.

Response: Wetlands are not directly affected by present day operation and maintenance activities as most dredging activities do not entail disposal over-bank or on-bank.

Comment 3: The EIS recognizes that the placement of dredged materials in critical areas (side channel exits or entrances) may have deleterious effects and disposal in these areas is now avoided. The EIS should indicate how past practices have resulted in the placement of spoil in critical areas and discuss any measures that will be implemented to restore these areas particularly where side channels have been cutoff.

Response: Placement of dredged material has not been placed at the head of side channels since 1958 with passage of the Fish and Wildlife Coordination Act, even then it was not a common practice.

Comment 4: Spoil disposal, either on-shore or into the open water, constitutes the primary adverse environmental impact associated with the operation and maintenance of the navigation channel. In spite of its importance, however, the EIS does not contain a comprehensive spoil disposal plan.

Response: Dredge material placement is generally planned on an annual basis. Upon selection of placement sites either on-shore or open water the individual dredge cut and placement site maps are forwarded for review by those conservation agencies participating in the overall coordination of dredging functions in Pools 24, 25 and 26. These documents may be noted as comprehensive dredge material placement plans. Under standing operating procedures, there are no long range comprehensive dredge material placement phases because of the impossibility of predicting the exact location of dredge cuts and placement sites on a continuum greater than one year. Therefore, the term comprehensive tends to be misleading.

Also, it should be noted that representatives of EPA attended a river inspection and proposed dredging coordination field trip, April 28 to May 1, 1975 from Saverton, Missouri to Cairo, Illinois.

Comment 5: Attributing a beneficial use of dredged spoil to provide wildlife habitat is not valid or reconcilable on a short-term basis. Furthermore, it doesn't take into consideration the loss of one type of habitat for another. The EIS indicates that in many cases natural revegetation of spoil areas has not occurred because of repeated deposits of spoil. Also, where woodlands have been subjected to disposal but not with sufficient frequency to cause mortality, the trees have been partially killed or stunted and the understory has been lost. Usually diverse aquatic or terrestrial habitat are converted into sterile sand-shoals and piles providing a poor substrate.

Response: The Draft Statement did not allude to dredge material as wildlife habitat. The only overbank placement of dredged material occurs along the Illinois River. Section 4.1.2.2 discusses the areas dredged and placement areas. Plate 11, Dredging Location Matrix, Illinois River has been added to the Final Statement and it illustrates that several locations have had repeated placement of dredged material. Initial surveys along one of the Illinois River disposal sites (river mile 77.5 to 78.5) in July 1975 did not show destruction of the larger trees and a regrowth of the understory was occurring. We do concur that repeated disposal at the same site does lead to a degeneration of wildlife habitat.

Comment 6: Although some data is provided, the EIS is lacking an adequate description of the dredge spoil. A complete sediment analysis and characterization would facilitate prudent selection of spoil sites and would also serve as a basis for determining the usefulness of spoil in recreation areas and the prospects for revegetation of spoil sites. Omitted is any reference to a definite time span in which revegetation may occur.

Response: The need for complete sediment analysis and characterization study of dredge material is a recognized need and warrants further study. The reader is referred to the Statement of Findings which spells out the position of the St. Louis District on the needs for future study.

Comment 7: The final EIS should identify the areas considered as "on or near the banks". If these spoil locations include backwaters, marshes, sloughs and areas behind wing dams, the deposition would result in a significant impact upon the biological stability of the river system. Although the impact of the spoil deposition at an particular site is not completely irreversible, in general, sites covered to any measurable extent cannot revert to their original state for extremely long periods of time. Repeated spoiling serves only to aggravate this condition, resulting in relatively permanent changes in flora and fauna.

Response: The dredged material sites are adequately mapped as to their locations on Plates 9A-D.

Comment 8: The EIS fails to identify what varieties of wildlife can be supported on nearly sterile sand piles. In addition, the dynamic nature of flood plain habitats preculdes the formation of large areas of uniform habitat types. Therefore, the diversity of an area is decreased through spoiling rather than increased as suggested.

Response: The Draft Statement adequately discusses this item in Section 4.2.2, Terrestrial Communities.

Comment 9: The EIS fails to discuss dredging operation and spoil disposal with regard to impacts on the Federal and State managed wildlife refuges on or along the inland waterway systems. Specifically, information is not provided on regulations or assessments made on spoil deposition on or near these protected areas to evaluate potential environmental impacts caused by operation and maintenance procedures. Also, the relationship of pool regulation to the management of these areas and recommendations made by management agencies should be discussed. Recreational developments such as docks and concessions are referred to in the EIS as minor in magnitude. The maintenance of docks however may require periodic dredging. The EIS should discuss the dredging, disposal of spoil and associated environmental impacts relating to the maintenance of adequate depths for those activities related to private dredging.

Response: There is little or no impact on wildlife refuges as dredge disposal has been coordinated with conservation agencies since 1958 (Fish and Wildlife Coordination Act). Pool regulation is adequately discussed in Section 1.3.2, Pool Regulation. Private dredging is handled under permits issued under Section 10, U.S. Code 33-403, 1899 River and Harbor Act and material disposal under permits issued under Section 404, Public Law - 92500.

Comment 10: The EIS should describe how the town of Grafton has been troubled in recent years by deposition in five small tributary streams. This discussion should address why the problem is of recent nature and what upstream improvements could be utilized to minimize the sedimentation.

Response: The discussion of sediment deposition in tributary streams, Section 4.1.1.3, Long Term Geomorphic Responses is considered adequate as is stated, "The tributaries show evidence of aggradation but not all of this can be attributed to higher water levels created by the locks and dams. Channelization and increased agricultural and urban activity are also factors".

Comment 11: It is stated in the EIS (p. 172), "Increasing the height of a low dike field can be effective in producing a dependable navigation channel if the dikes are not too short in relation to the river width. In the study area, there are no new dikes planned". This discussion indicates the effectiveness of increasing the height of a low dike field and mentions that no new dikes are planned; however, the discussion implies that the heights of low dike fields may be increased. The EIS should discuss any plans or proposals to raise low dike fields.

Response: There are plans for repairing nine dikes in Pool 25 (five dikes) and Pool 24 (four dikes). The plans have been circulated for review by environmental organizations.

Comment 12: According to the EIS, much progress has been made in eliminating excessive amounts of timber clearing and bank grading in the navigation pools. This discussion should be expanded. The problems experienced with timber clearing and bank grading in the past should be described and the progress that has been made in eliminating these problems should be explained in more detail.

Response: Bank grading in the past was associated with the building of revetments. There are no new revetments planned in the study area.

Comment 12a: According to the EIS, there has been a net deposition of sediment in Piasa, Elsah, and Chautauqua Creeks in Illinois since the bridges were constructed, and that the State highway departments frequently clear sediment from the channels tributary to both the Mississippi and Illinois Rivers. This discussion should be expanded to address the disposal practices, environment impacts and the relationship of this activity to Section 404 of the Federal Water Pollution Control Act Amendments of 1972.

Response: The material excavated from the above cited tributary channels is removed from the respective locations and deposited in approved landfills.

Comment 13: As indicated in the EIS, one of the principal effects on water quality is the increase in turbidity caused by dredged churnings and spoil disposal. However, associated with this release of material one can usually find a decrease in available oxygen, increased conductivity, increased phosphates, additional total nitrogen and any other pollutant contained in the spoil. A study of dredging effect on water quality in pool #8 during the summer of 1973 indicated significant changes did occur in turbidity, nitrate and nitrogen. Also, a substantial decrease in dissolved oxygen was observed. Measures to minimize these adverse impacts can be utilized with limited treatment of the returning overflow, i.e., by the use of dikes, successive ponding or retention basins. Selective monitoring for changes in water quality in areas of spoil disposal should be initiated whenever maintenance activities have the potential to adversely effect water quality, particularly in the vicinity of recreational areas and eco-sensitive wetlands such as spawning grounds or waterfowl habitats. Whenever State water quality standards are violated, the implementation of appropriate pollution abatement measures will be required as per Sec. 313 of PL 92-500.

Response: Comment noted. Most of the dredged material placement in the study area is open water placement while along the Illinois there are no plans to utilize ponding or retention basins to treat returning overflow. As discussed in Section 4.1.4, Impact on Water Quality, the studies conducted by WES showed in this pooled reach of the river, the impact of the resuspension of sediments is minimal. LMVED-WR, Regulation No. 1110-2-205 (Nov. 10, 1975) Water Control Management Water Quality, Section 9 - Water Quality at Corps Dredging Sites, states "-- A program should be established to monitor water quality at Corps of Engineers confined and unconfined disposal areas where water quality control measures are instituted to determine the effectiveness of such measures, and at other sites specified by the Regional Administrator EPA pursuant to Section 308 of the Federal Water Pollution Control Act --".

Comment 14: Since pesticides, metals, sulfides, methane, oil and grease, ammonia and other substances, if present in the bottom sediments, can be released into the water column by resuspension of the sediment or from disposal areas, the locations of water intakes should be identified and measures to avoid degradation nearby water supply intakes should be described.

Response: Concur. The following is a list of water supply intakes located within the study area:

USER	LOCATION	TYPE OF USE
City of Louisiana, Mo.	RM 282.6	Municipal Water Supply
Hercules Powder Co.,Mo.	RM 280.9	Industrial Processing
Union Electric Co., Mo.	RM 209.8	Power Generation
City of Alton, Ill.	RM 204.2	Municipal Water Supply

The above listed water supply intakes are located on the Mississippi River. There are no water supply intakes located on the Illinois River within the study area. Should dredging activities need to be performed near these water supply intakes, notification of this work will be given to the respective user. Also, precautions will be taken by the St. Louis District within the guidelines of LMVED-WR, Regulation No. 1110-2-205, dated 10 Nov 75, "Water Control Management - Water Quality", para. 9, to ensure the least adverse impact on water supply intakes.

Comment 15: Water quality as well as aesthetics of some pools in the Upper Mississippi River would seemingly have a bearing on the demand for beaches. The potential health risks of providing beach areas which induce water contact recreation such as swimming, wading, or water skiing must be carefully studied with regard to water quality and applicable water quality standards. Where water quality is poor and not suited or safe for whole body contact, the development of beaches for recreation should be discouraged.

Response: It is recognized that water quality should be one of the criteria evaluated prior to the development of recreational beaches. However, the main purpose of O&M dredging activites is maintenance of the 9-foot navigation channel and not the development of beaches. Those beaches which have resulted from dredging activities are considered a side benefit to the project. In the future, the St. Louis District under the guidelines of LMVED-WR Regulation No. 1110-2-205, Water Control Management - Water Quality, dated 10 Nov 75, will consider the parameters of water quality as they pertain to dredging activities in this pooled reach of the river.

Comment 16: It is difficult to make an objective assessment of water quality problems using the minimal amount of information provided in the EIS. In addition, no data is presented assessing the adverse impacts of the actual dredging and spoiling operations. An adequate description of the dredge spoil should be provided for major areas of dred ing as soon as practicable. Adequate analysis and characterization of the sediments would insure compliance with our acceptability criteria for spoil disposal, facilitate prudent selection of spoil sites and also serve as a basis for determining the compatability and usefullness of the spoil. Although some data were provided in the EIS, it is not clear if the data are representative of all dredge sites.

Response: The data presented in Table 9, Appendix B, are representative of only those river miles in which sampling occurred. It is recognized that available water quality data presented in the Environmental Statement are insufficient for use in assessing water quality problems for this pooled reach of the Mississippi and Illinois Rivers. LMVED-WR Regulation No. 1110-2-205 (10 Nov 75) Water Control Management - Water Quality, Section 8 - Water Quality at Corps Dredging Sites, states --- "A program should be established to monitor water quality at Corps of Engineers confined and unconfined disposal areas where water quality control measures are sintituted to determine the effectiveness of such measures, and at other sites specified by the Regional Administrator EPA pursuant to Section 308 of the Federal Water Pollution Control Act---".

Comment 17: Section 1.6 of the EIS should include a discussion of the GREAT I and GREAT II Studies which are now being conducted in the St. Paul and Rock Island District reaches of the river. This river management study is a direct result of the concern over severe environemntal damages resulting from the past practices utilized by the Corps. The GREAT Study for the St. Paul District has been functioning for nearly one year and has developed numerous new ideas for correcting current environmental abuses. The GREAT is considering both short and long range problems and their solutions and can be applied in general to the St. Louis District. The GREAT II study is still in the early stages of development and will follow the precedent set by GREAT I and the overall objectives developed by the Dredge Spoil Disposal Practices Committee for the entire Upper Mississippi River. GREAT III is anticipated for the St. Louis District in the future. We urge full support by the St. Louis District COE in this effort.

Response: Comment noted. The Statement of Findings addresses the need for a more comprehensive river management study.

Comment 18: In addition to the information requested above regarding water quality, we believe the following detailed long-range studies should be initiated to determine measures to substantially reduce the adverse effects associated with future operation and maintenance activities on the river. Such studies should include:

1) a comprehensive bottom sediment analysis of the river;

2) the short and long range effects of O&M activities upon water quality;

3) a qualitative and quantitive description of the wetlands, back-water areas, and woodlands impacted by O&M activities;

4) the general environmental effects of dredging sloughs and back-water areas;

5) the dynamics of sediment movement induced by dredging and disposal activities, and

6) a comparison of the overall effects associated with disposing the spoil within the lower limits of the flood plain to disposing of the spoil outside the floodway.

Response: The need for such studies as indicated by items 1), 2), 3), 4), 5) and 6) are recognized in the Statement of Findings. More specifically: 3) a most comprehensive study of the wetlands and woodlands was performed by the Missouri Botanical Garden and was one of several studies which formed the background data for the Environmental Statement, 6) Section 6.2, Selective Placement of Dredge Material, represents the best knowledge of the District at this time.

Comment 19: The evaluation of alternatives to the project is incomplete. Only two major alternatives to the existing operation and maintenance procedures are presented: discontinue operation of the locks and dams, and discontinue maintenance of the navigation channel. The other alternatives discussed are only modifications of the present dredging and spoil deposition techniques.

Response: While discontinuence of operation and maintenance of lock and dams, and the navigation channel is not really realistic, its discussion is required under Section 1500.8 (4) Federal Register, May 2, 1973 guidelines of the Council of Environmental Quality. Under the direction of Congress, "River and Harbor Act of 3 July 1930," 46 Stat. 918, 33 USC. 426 et seq as amended the Corps of Engineers St. Louis District, is required to continue operation and maintenance of the navigation channel. Therefore, those alternatives which are presented in Section 6.2 are the most complete based on all data available at the present time.

Comment 20: The alternatives of increased spoil disposal flexibility, revegetation of disposal sites, commercial use of dredge spoils, watershed land-treatment and development of recreational facilities have great potential in reducing adverse social, environmental and economic impacts. These alternatives should be incorporated whenever possible in maintenance dredging practices to alleviate adverse impact and should receive full consideration in your agency's decision-making process. Not in every case should only one method be used. Instead, all or a composite of these alternatives should be considered now and during future studies to determine their maximum environmental and economic public benefit. Revegetation of dredge spoils also appears to be a very viable alternative. It is recommended that future studies be undertaken to determine the feasibility of this alternative. A major environmental problem as stated in the EIS is the movement of dredge spoils by erosion. This alternative has great potential for partially correcting this problem in an effective way, environmentally and economically.

Response: Comment noted. The alternatives for the selective placement of dredge material are discussed in Section 6.2. The Statement of Findings recognizes the need for continuing environmental studies. Presently, the St. Louis District has no plans for revegetating those areas of overbank placement along the Illinois River as natural vegetation is occurring on these sites.

Comment 21: Consideration should be given to potential markets for spoil and the benefits to be derived from removal of the spoil from the river area. Included in this discussion should be a comparison of the long-term costs (especially environmental costs) of remote or central spoil disposal and the costs of the maintenance and operation program as it is practiced today.

Response: There is no available data from which a complete analysis of potential markets for dredge material may be constructed. The reader should refer to the Statement of Findings which spells out the position of the St. Louis District on the needs for future study.

Comment 22: Watershed land treatment should be considered for the tributaries that are known to be conveying extensive sediment loads to the Mississippi River. Attacking some of the causes of the sedimentation problem instead of its effects should substantially reduce dredging impacts and also have positive impacts upon both tributary streams and the Mississippi River. The use of spoil material for landfill or other purposes should be completely addressed as an alternative to present practices including an evaluation of economics vs. environmental costs.

Response: Comment noted. As is recognized in the Environmental Statement, little is known about the contribution of sediment by the small tributary streams to the riverine systems. The Corps is willing to work with other agencies, such as the Soil Conservation Service, in solving the problem of watershed land treatment. The use of dredge material as landfill is addressed in Section 6.2.4, Stockpiling Dredge Material.

Comment 23: The discussion of alternatives mentions that a discontinuation of the waterway service would force the utilization of other costlier modes of transportation. This statement may be true, however, since transportation rates are regulated by the Federal government, these rates are subject to change. In addition, Federal subsidy to particular carriers necessarilly absorbs a portion of the full cost of the operation by the carrier. The EIS should compare the costs and the rates of various transportation modes with and without existing rate regulations and subsidies. The National Water Commission Report discusses the major relating to the development of water resources. One of the recommendations of the Report concerns user fees for navigation interests. This recommendation should be discussed as an alternative in the EIS.

Response: Comment noted. The various transportation modes are discussed in the Final Environmental Statement and Supplement, Lock and Dam 26, Replacement.

Comment 24: The final EIS should also evaluate and compare the environmental impacts of the alternatives to waterborn transportation. These should include but not be limited to movement by rail, truck or pipelines or a combination of these modes with any other mode including barging.

Response: Comment noted. See response to Comment 23 above

Comment 25: The EIS does not evaluate the long-term effects of spoil disposal on recreation. The continuous deposition of spoil on recreation areas must eventually reduce the suitability of the sites for recreation and either new spoil disposal sites will have to be selected or recreation activities will be eliminated. These long-term impacts of spoil disposal upon recreation areas should be addressed in the final EIS.

Response: Disagree. Continuous disposal of dredge material is essential to the maintenance of a good recreational beach. Growth of vegetation along the beach is not desired by the beach users. (Bach, 1975).

Comment 26: All of the impoundments are characterized by a gradual process of sedimentation or filling particularly in areas outside the navigation channel. The operation and maintenance program for the 9-foot channel accelerates the rate of deposition in these areas by decreasing water velocities in backwater areas, direct spoil disposal, spoil disposal which impedes flows leading into or out of backwater areas, and spoil disposal which returns to the river. The EIS should acknowledge this gradual sedimentation process with regard to long-term impacts and discuss them in detail. An attempt should be made to predict the changes in physical and biological characteristics of the Upper Mississippi River through the next 100 years and beyond assuming existing maintenance activity continues. Long-term effects should take into consideration not only the consequences upon flood plain and lowland uses, wetlands, bottomlands forest, sloughs, and backwater areas, but also the constriction of the existing meandering waterway, development of a uniform navigation channel and sedimentation and deposition in each pool.

Response: The Environmental Statement does acknowledge the gradual sedimentation process in side channels and acknowledges that further studies need to be undertaken to understand side channels. Section 2.1.2.4, The Future, describes a model study undertaken by Colorado State University to predict conditions in the pools to the year 2025.

Comment 27: The EIS privides a generous amount of information on the "beneficial" effects of the impoundments upon recreation, fish and wildlife. The final statement should predict the long-term effects, both beneficial and adverse, upon recreation, fish and wildlife resulting from the maintenance of the 9-foot navigation channel. It appears that the long-term benefits of the present maintenance program favor commercial navigation at the expense of recreational; fish and wildlife uses. More emphasis should be placed on enhancement and maintenance of the value of the river for uses other than commercial navigation.

Response: The data gathered for this Environmental Statement is considered baseline data which is the first effort in a long-term study program. The Statement of Findings recognizes the need for further studies.

Comment 28: The EIS does not discuss the effects of dredging and spoil disposal upon the hydraulic characteristics of the Mississippi River. Natural sedimentation behind the wing dams combined with spoil disposition in the off-channel areas continues to constrict the river channel. This reduction in channel capacity may affect the river stages, particularly the flood stages. Higher flood stages would result in the need to raise the levee systems downstream and modifications of the levees could have a significant impact upon the river and riparian environments. Consequently, we believe the EIS should contain the primary and secondary impacts of any changes in the river stages upon the Mississippi River system.

Response: The Environment Statement is most complete in the discussion of the physical characteristics of the river and recognizes the need for further study. River stages are adequately addressed in Section 4.1.1.4, Effect on Discharge and Stages.

Comment 29: In conclusion, we believe the following general approach should be used in relating to the environmental impacts of O&M activities on the Upper Mississippi River. This approach will designate EPA's general recommendations regarding dredging and spoil disposal in the Upper Mississippi River.

1. The need for greater flexibility in the handling and disposal of dredged spoil is required because of the adverse impacts upon environmentally sensitive areas. Additional expenditures for longer pipelines, booster and pump-out equipment and transport barge may be necessary to increase the flexibility of O&M activities.

Response: Concur. Figure 6-3, "Discharge Range Model" and Plates 12A-P, "Dredge Material Placement Capabilities" have been added to the Final Statement. The corps recognizes that additional equipment would increase placement flexibility and further cost feasibility studies will be made in the future as a part of O&M activities.

Comment 30: The practice of retaining spoil in and adjacent to the waterway should be modified. The adverse effects of the existing program upon water resources and wetlands are apparent. Where feasible, we believe spoil should be moved as far away from the river as practicable to prevent its redeposition in the river. This approach will not be necessary in every case, but where shoaling is intense and dredging requirements are extensive, it should be encouraged. Furthermore, if sensitive wetlands or bottomland forests exist in the vicinity, spoil should also be removed to a more compatible area, preferably outside the floodway. Placement in fringes of the flood plain would probably be acceptable.

Response: Comment noted. The environmental effect of dredge disposal on wetlands is minimal in that dredge material is placed in the narrow zone between the Illinois River and the levee. This narrow strip is an active zone of erosion and deposition and is not a sensitive wetland. The problem of removal from the floodplain is discussed in Section 6.2.7, Removal from the Floodplain.

Comment 31: The existing program of selecting spoil disposal sites is in need of modification. Regardless of the fact the infrequent spoilage in some areas has created a few diversified ecosystems, the usual results are sterile sand-shoals that either directly impinge upon or indirectly through sedimentation and redeposition adversely impact environmentally sensitive areas such as spawning and fishing grounds, waterfowl habitat, and other wetland or bottomland habitats. With care and coordinated agency planning, this kind of impact can be avoided.

Response: Section 6.2 addresses the problems of selective placement of dredge material. Figure 6-3, "Discharge Range Model" and Plates 12A-P, "Dredge Material Placement Capabilities" have been added to the Final Statement. The Corps recognizes the need for coordination of the selection of disposal sites and has done so for several years.

Comment 32: The load capacity of a given area to successfully retain spoil deposits and support a viable ecosystem is an important factor that has been overlooked in the past and should be given careful study in the future. When selecting sites for disposal, consideration should be given to the frequency of spoil disposal, the quantity of spoil, and the type of area affected.

Response: Comment noted.

Comment 33: Bottom sediments of each pool should be periodically monitored (3-year intervals) to determine their quality and character for a compatible program of disposal with local ecosystems. Bottom sediments that are found to be polluted must be confined in a disposal facility.

Response: We concur. LMVED-WR Regulation No. 1110-2-205 (10 Nov 75) Water Control Management - Water Quality, Section 9, Water Quality at Corps Dredging Sites states ---"Discussion of water quality activities conducted relative to Corps dredging activities should be included in the annual Water Quality Report."--- "Sampling in connection with monitoring activities should be conducted by Corps inspectors on the sites--".

Comment 34: Where necessary, pollution abatement structures for given disposal areas should be constructed and completed prior to the disposal of spoil. Stabilization of the disposal area is an important measure that should be implemented after spoil deposition. Stabilization measures such as revegetation and erosion control are necessary to minimize water and wind erosion and redeposition in the river.

Response: There are no abatement structures planned for on-bank disposal sites along the Illinois River. Dredge material is usually placed between the levee and the river in an area that is periodically inundated and is an area of active deposition and erosion.

Comment 35: In order to improve the understanding of O&M activities on the Upper Mississippi River, studies to determine the composition of bottom sediments, short and long range water quality effects, the nature of sensitive areas, effects of dredging backwaters, the nature of sediment movement and effects of spoil placement should be undertaken as soon as possible.

Response: Comment noted. This need is recognized in the Statement of Findings.

Comment 36: Recommendations proposed by the Upper Mississippi River Conservation Commission in their 1969 Upper Mississippi River Dredge Spoil Survey should be considered as alternatives to present dredging activities. Basically the Commission recommended an evaluation of current deposition practices in order to detect and eliminate environmentally harmful practices. Several excellent recommendations for selection of future spoil sites as discussed in the survey. Adherence to these recommendations will aid in elimination of damages resulting from maintenance and operation of the 9-foot channel.

Response: Comment noted.

Comment 37: The disposal of dredged material shall be consistent with the EPA Section 404 Guidelines for Discharge of Dredged or Fill Material (Federal Register dated September 5, 1975).

Response: The St. Louis district will continue to cooperate with EPA as to operation and maintenance procedures, and to comply with all applicable laws and regulations.

b. UNITED STATES DEPARTMENT OF THE INTERIOR, NORTH CENTRAL REGION CHICAGO, ILLINOIS. (Letter dated August 29, 1975).

Comment 1: GENERAL: This document de-emphasizes the causes and effects of side-channel sedimentation. The effect of dikes and revetments in preventing the formation of the new side channels is not mentioned, which thus gives a misleading picture of project effects.

Response: It is not the intent of this document to de-emphasize the causes and effects of side-channel sedimentation but to call to the attention of the reader how little is really known about chute closure. Sediment delivered by tributaries to side-channels is probably deposited permanently. Dikes have little or no effect within the Upper Mississippi River while revetments are used to help stabilize the bankline. Thus, revetments may help keep the river from migrating across the floodplain. These effects were discussed in section 4.1.2.3 of the Draft Statement.

Comment 2: Also, because of incomplete information, it is not possible to evaluate project effects on the mussels of the Illinois and Mississippi Rivers.

Response: Additional information on mussels has been added to the statement. It is the Corps of Engineers' position that sufficient information has been presented to adequately evaluate the impacts on mussels.

Comment 3: SPECIFIC: Part I - PROJECT DESCRIPTION - Figure 1-4 and 1-6 - Are the proposed recreation areas to be developed by the Corps of Engineers?

Response: The proposed recreation area at Foley is the only project planned for development by the Corps of Engineers. Discussion of proposed development of Corps of Engineers recreation facilities will be contained in the revision of the Master Plan of 1961 which is currently in progress.

Comment 4: Page 20 - To avoid misunderstanding, the fourth paragraph should indicate that it has been standard procedure to over dredge to a depth of 11 or 13 feet below minimum pool elevation.

Response: Comment noted. Reference paragraph 4, sentence 2.

Comment 5: Page 23 - 1.6.2.2 State of Illinois Recreation Plan - A more recent State comprehensive outdoor recreation plan, Illinois Outdoor Recreation, prepared by the Illinois Department of Conservation, was released in December 1974.

Response: Illinois Outdoor Recreation, 1974, has been added to the discussion of the State of Illinois Outdoor Recreation Plan. However, the document, financed in part by the Department of Interior, is more in the line of an inventory of existing resources, and a statement of goals and objectives, setting the policy direction Illinois desires to take.

Comment 6: Page 85-d. Benthos - The treatment of mussels in this section is inadequate. Several common species were not recorded, including: *Anodonta grandis*, *Arcidens confragosus*, *Lampsilis anodontoides*, *Fusconaia flava*, and *Proptera laevissima*. No mention is made of the commercial value of mussels, even though in 1966 there were 36 commercially fished mussel beds on the lower 80 miles of the Illinois River. The location and abundance of mussels is especially important in evaluating project effects since they are benthic organisms easily disturbed by dredging and spoil disposal.

Response: An addition species list from the literature has been placed in the environmental statement. Also this section of the statement has been expanded to consider the commercial importance of mussels.

Comment 7: Page 122 - Several species of mussels listed by Missouri as rare or endangered are known to occur in the Upper Mississippi River. These include: *Arcidens confragosus*, *Obovaria olivaria* and *Quadrula nodulata*.

Response: The environmental statement has been changed to list the species of *Arcidens confragosus*, *Dysnomia triquetra*, *Elliptio crassidens*, *Lampsilis orbiculata*, *Obovaria olivaria*, *Plethobasus cyphus*, *Proptera capax*, and *Quadrula nodulata* from Rare and Endangered Species of Missouri, that have been recorded from the Upper Mississippi and Lower Illinois Rivers.

Comment 8: Page 143 - 2.5 OUTDOOR RECREATION - It would be helpful if the major recreation areas and parks were shown on a map.

Response: Major recreational areas and parks are graphically displayed on Plates 6-A thru 6-D as Public Open Land.

Comment 9: Page 169 - 4.1.2.2 Dredging and Disposal - Coordination of dredge spoil placement with conservation agencies does not always ensure that no adverse impact will occur. The penultimate paragraph also should state that frequently, because of cost and equipment limitations, spoil is not placed in the locations preferred by the conservation agencies.

b. U.S.D.I.

Response: Dredge material placement sites are selected within the parameters of the least cost method of operation. The draft had been revised to incorporate Plates 12A-P which graphically illustrate the present range capabilities within critical areas of the existing plant generally used to perform dredging in Pools 24, 25 and 26. Preliminary data has been developed to investigate the feasibility of increasing discharge ranges for placing dredge material at preferred locations (ref. Sect. 6.2.1 2nd paragraph). In addition, Plate 13 illustrates how discharge range is a function of cost. It is felt that continued coordination with various conservation agencies is the best available method of ensuring that dredge material site selection occurs with the least adverse impact within the limitation of existing plant capabilities.

Comment 10: Page 180-b. Revetments - Although revetment may contribute to aquatic habitat diversity to some small degree, it also effectively prevents the formation of any new side channels or off-channel lakes. As such, revetment cannot be considered beneficial to the aquatic communities.

Response: Comment noted. The Draft Statement states: "Revetments---provide additional habitat diversity for aquatic communities and therefore may be beneficial." It is true that the purpose of revetments is to prevent lateral migration of the channel.

Comment 11: Page 183 - Overbank Dredge Materials - The effects of spoil disposal on terrestrial vegetation is understated. The term "important species" should be defined or deleted. Frequently, spoil material is biologically sterile and years are required for even a sparse vegetative cover to reestablish itself on a disposal site. This lack of vegetation not only destroys the wildlife habitat value of the area, but also causes the spoil to be easily eroded back into the river.

Response: The Draft states "Dredged materials deposited overbank have the direct effect of killing the covered vegetation"; that is not an understatement. Most sand bars, natural or dredge material, which are submerged during most of the year lack vegetation and are easily eroded.

Comment 12: Page 184-b. Maintenance Dredging and Placement of Dredged Material - Spoil material placed in the river may provide resting and loafing habitat for certain birds; however, there is a complete loss of aquatic habitat under these circumstances.

Response: Comment noted.

b. U.S.D.I.

Comment 13: Page 185- IMPACT ON THREATENED, RARE OR ENDANGERED SPECIES - The silting in of sloughs and side channels does not create habitat diversity, as indicated in the second paragraph under this heading; rather, such silting reduces habitat diversity.

Response: The statement has been removed from the Final Statement as the increase in habitat diversity is temporary.

Comment 14:

The least tern is the only rare or endangered bird breeding in the study area that requires sandbanks for nesting. Even for this species, there have been no recent breeding records in the study area.

Response:

Concur. The Final Statement has been changed in Section 4.2.3

Comment 15: Page 188 - 4.5 IMPACT ON OUTDOOR RECREATION - This section requires more discussion. It is unclear why the project "will have no impact on existing recreational resources or use of the sites" but "recreation on the Upper Mississippi and Lower Illinois Rivers proper. . .will suffer adverse effects." Specific adverse impacts have not been enumerated. Impacts from dredging such as turbidity and spoil disposal sites should be discussed. Possible enhancement to recreational navigation and beach nourishment also should be treated. Adverse impacts also should be enumerated in Part 5.

Response: None of the formal existing recreational use sites i.e., state parks, will be impacted by the projects. This is discussed in Section 4.4.b, Impacts on Land Use, Recreation, of the Draft Environmental Statement. This lack of impact is due to the geographical location of the sites in relation to the dredging activities, as well as the selective placement of dredge material into open water. Instead, the project itself has major recreational potential. The principal manner in which navigation is maintained, i.e., the pooled condition, enhances recreational use. The dredged material has been utilized for recreational activities within Pools 24, 25 and 26, by way of forming temporary sand beaches to the side of the main channel. These beaches experience intense use by recreational boaters.
The statement on adverse impacts on recreation on the River proper refers to the recreation on the river itself, as opposed to the banks or beaches. Along this line, the greatest adverse effect will be on sport fishing. This impact is discussed in Sections 4.2.1 and 5.2.3. The adverse effects of dredging such as turbidity and disposal sites are discussed in Sections 5.2.1, 5.2.2, and 5.2.3 of the Draft Environmental Statement.

The enchancement of recreation boating in the study area by the pooled condition of the river and the dredged material beaches are discussed above.

b. U.S.D.I.

Comment 16: Page 188 - 4.6.1 ARCHEOLOGY - It is encouraging to note that a comprehensive shoreline archeological survey is currently under way along the lower Illinois River. We hope that the results of this survey will be presented in the final statement. Also, we suggest that such a survey be conducted of the shoreline of pools 24, 25, and 26 in order to insure that future recreational developments, industrial development, or any number of water-related land uses do not adversely affect significant historical and archeological values. The statement should present procedures to be implemented in the event that previously unknown cultural resources are encountered during project construction.

Response: The comprehensive archeological survey initiated along the shoreline of the Illinois River was undertaken because of the potential for direct impact - i.e. on-land placement of dredged material - existed for the entire shoreline area. For pools 24, 25, and 26 on the Mississippi River the potential for direct project impact through the on-bank placement of dredged material does not exist, since dredged materials are placed back in the river. In view of this fact an archeological survey of the entire shoreline would not be within the preview of federal regulations. Archeological surveys of shoreline areas in pools 24, 25, and 26 will as such, be limited to those areas which will involve disruption of the ground surface which are a direct result of Corps of Engineers actions.

Comment 17: Page 189 - 4.6.2 HISTORY - We suggest that the determination that no historic sites will be disturbed by operation and maintenance activities reflect consultation with the State Historic Preservation Officers for Missouri and Illinois.

Response: Discussion on an informal basis concerning the potential effects of operation and maintenance activities took place on several occasions with staff of the Missouri Department of Natural Resources, State Historical Survey and Planning Office; and with persons in the Illinois Archeological Survey. Views of these agencies on the effects of the project are contained in this statement.

Comment 18: The alternative of providing the 9-foot channel depth for only a portion of the navigation season should be considered. It is possible that a significant amount of environmental damage could be avoided by allowing the navigation channel to be less than 9-feet deep for a small portion of the year.

Response: Under the direction of Congress, "River and Harbor Act of 3 July 1930," 46 Stat. 918, 33 USC. 426 et seq. as amended the Corps of Engineers St. Louis District, is required to maintain a navigation channel 9-feet deep by 300 feet with additional width around bends at low water on a continued basis. A deviation in the operation and maintenance of the 9-foot channel could come about only under the direction of Congress.

b. U.S.D.I.

Comment 19: Page 200 - 6.2.3 RECREATIONAL POTENTIAL - A qualified statement should be substituted for the first sentence of the third full paragraph on this page. The effect on the aquatic community of using dredge spoil to develop recreational areas will vary depending on the site.

Response: This paragraph has been changed to indicate that the effects will differ with location.

Comment 20: Page 202 - Twenty-five percent plant cover in 5 years is not "fairly rapid" revegetation. Within the study area, normally fertile soil has nearly 100 percent plant cover within 1 year after being disturbed.

Response: Text has been changed accordingly. The character of dredge material does not resemble fertile soil in that it is composed primarily of sand and silt sized particles. (See Tables 10 and 11, Appendix B).

Comment 21: Page 203 - 6.2.7 REMOVAL FROM FLOOD PLAIN - The term "effective biological life" should be defined. The removal of dredge spoil from flood plain could significantly reduce the rate of sedimentation in backwater areas.

Response: The modifer "effective" has been removed from the statement. It is not known if the removal of dredge material from the flood plain would reduce the rate of chute closure.

c. UNITED STATES DEPARTMENT OF AGRICULTURE--FOREST SERVICE NORTHEASTERN AREA, STATE AND PRIVATE FORESTRY UPPER DARBY, PENNSYLVANIA. (Letter dated August 20, 1975)

Comment 1: Continued maintenance of the same channel will eventually result in drying up of wetlands that are associated with the changing channels of a meandering stream. On wildlife habitat the effect of "fixing" the channel should be discussed more fully. The final statement should also attempt to quantify the amounts of marsh and other habitat gained and lost by the effects of pool regulation.

Response: The siltation of wetlands is a natural process which is aggravated by sediment loads eroded from adjacent agricultural and urban lands. The present day habitat has been adequately mapped and pool operations do not have a significant effect upon adjacent wetlands.

Comment 2: Increased use of vegetation, including trees and shrubs, should be considered for stabilizing dredge spoils on and near streambanks. Under appropriate conditions such vegetation will reduce redeposition of sediment into the channel and lengthen the time between dredging projects.

Response: Dredge material is deposited overbank on the Illinois River, usually in vegetated areas between the levee and the river. This section of the riverine environment is inundated much of the year and natural revegetation is more effective in stabilization than plantings.

d. UNITED STATES DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE - MISSOURI. (Letter dated August 20, 1975)

Comment 1: The statement would be strengthened by the addition of the plans for erosion control where stockpiling or overbank placement is a possible alternate. It is important that stockpile sites be chosen avoiding impacts to soils which have high value for agriculture. This office will provide assistance for erosion control and identification of important agricultural land where possible.

Response: At present, dredged material is not stockpiled for economic utilization and overbank placement largely occurs between the levee and the Illinois River in areas that are marginal agriculturally due to periodic inundation.

Comment 2: The operating levels of pools are important. Many conservation measures--particularly drainage--could be affected. Outlets have been, and will continue to be, designed based on the anticipated pool elevations maintained by locks and dams. Any changes in the elevations could affect these outlets.

Response: Concur. Pool elevation levels are part of the total scheme in the operation and maintenance of the 9-foot navigation channel as established by the construction of Locks and Dams 24, 25, and 26 under the authority of Congress. (Ref: "River and Harbor Act of 3 July 1930, 46 Stat. 918, 33 USC. 426 et seq. as amended"). Normal pool elevations will continue to be maintained unless otherwise changed by Congressional action.

e. UNITED STATES DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE - ILLINOIS. (Letter dated September 4, 1975)

Comment 1: On page 210, line 7 - suggest the word "Service" be deleted to make it read correctly.

Response: Concur. The word "Service" has been deleted in the Final Statement.

Comment 2: The statement would be strengthened by the addition of the plans for erosion control where stockpiling or overbank placement is a possible alternate. It is important that stockpile sites be selected which would avoid adverse impact to soils which have high value for agriculture. This office will provide assistance for erosion control and identification of important agricultural land where possible.

Response: Same as response 1, letter d., Soil Conservation Service, Missouri.

Comment 3: The operating levels of pools are an important concern to agriculture. Many conservative practices, particularly drainage, could be adversely affected. Outlets have been, and will continue to be, designed based on the anticipated pool elevations maintained by locks and dams. Any changes in elevations could affect these outlets.

Response: Same as response 2, letter d., Soil Conservation Service, Missouri.

f. FEDERAL POWER COMMISSION - WASHINGTON, D.C. (Letter dated August 13, 1975)

Comment 1: The staff notes that the three projects discussed in the draft statement are integral elements of the 9-foot navigation channel project on the Mississippi River from the mouth of the Missouri River upstream to Minneapolis. A number of fossil-fueled power plants located along this navigation waterway utilize fuels transported via the waterway. Thus, continued maintenance of the waterway to provide the fuels essential to the operation of these power plants can contribute to assurance of the adequacy and reliability of electric power supplies in this mid-continent area.

Response: Under the direction of Congress River and Harbor Act of 3 July 1930," 46 Stat. 918, 33 USC 426 et seq., as amended, the Corps of Engineers, St. Louis District is required to maintain a navigation channel 9 feet deep by 300 feet wide with additional width around bends at low water on a continual basis. Any deviation in the operation and maintenance of the 9-foot channel could come about only under the direction of Congress.

Comment 2: The staff also notes that the steam-electric power plants depend on the navigation waterway as the source of cooling water supply. Care should be taken to protect cooling water intake and discharge structures which are located in the segment of waterway occupied by Pools 24, 25, and 26 from maintenance activities of dredging and dredged material disposal.

Response: The St. Louis District makes every effort to plan operation and maintenance activities to protect any such facility.

g. DEPARTMENT OF HEALTH EDUCATION AND WELFARE REGION VII.
(Letter dated September 2, 1975)

Comment 1: We find that the project will have no impact upon programs of the Department of Health, Education and Welfare.

Response: Comment noted.

h. DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT - CHICAGO AREA OFFICE. (Letter dated August 26, 1975)

Comment 1: Your EIS carefully documented the importance of maintaining a nine foot navigation channel in this strategic section of the Mississippi River and the complex interrelationship between the maintenance of this channel and the quality of aquatic and terrestrial habitats.

Response: Comment noted.

Comment 2: Your information indicates that although most of the Corps' activities present limited viable alternatives the dredging action presents a real choice to decision makers. The EIS presents a choice of economic cost vs. aesthetic benefit. Since the Mississippi is a unique part of our cultural heritage it seems as if the increased cost, although significant (35% more for Kennedy & 66% more for Ste. Genevieve), is not prohibitive and might be warranted. The Corps' statement has served a useful purpose in delineating the scope of this choice.

Response: The St. Louis District will undertake a feasibility study of new dredge plant facilities.

1. DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT AREA OFFICE - ST. LOUIS, MISSOURI. (Letter dated September 2, 1975)

Comment 1: From the information contained in the draft statement, it does not appear that there are any conflicts with the plans or programs of this HUD Area Office.

Response: Comment noted.

Comment 2: First of all, one of your overall alternatives is to do nothing, open all the dam gates and let both rivers seek their own levels. It should be noted that Federal law including various River and Harbor Acts will not permit this. In fact, there is a specific law prohibiting the Corps from making any change in the levels of these rivers.

Response: Comment noted. The Guidelines of the Council on Environmental Quality specifically requires the discussion of a "no-action" alternative.

Comment 3: Criteria used to select dredge disposal sites should be clearly discussed and included in the statement. Consideration for erosion protection or containment should be explained.

Response: Section 4.1.2.2 discusses the selection of dredge disposal sites. Overbank disposal on the Illinois River is not contained nor protected from erosion, but is placed in an area which is actively a portion of the river during periods of high water.

Comment 4: Actually, there is both an energy and inflationary impact to consider in the draft statement. The recent energy shortage is a powerful incentive for reassessing our environmental project impacts. Therefore, the following evaluations should also be discussed and questioned.

1. Are there potential problems with the supply of energy required to operate and maintain Pools 24, 25 and 26?

Response: Under the present operating policies for the Operation and Maintenance of Pools 24, 25, and 26, anticipated energy supplies for the near future do not appear to be a problem at this time.

Comment 5: 2. Will the Operation and Maintenance consume excessive amounts of energy?

Response: Energy consumption in the Operation and Maintenance of the pools is not considered to be excessive under present energy standards.

Comment 6: 3. Will energy conservation technology be employed?

Response: The Corps of Engineers, St. Louis District, is continually cognizant of national energy problems and will employ acceptable energy conservation technology within the guidelines of existing and future National Energy Policy.

Comment 7: We trust that continued study and research will be spent on the fabric of interrelations among all living things in and along the Mississippi and Illinois Rivers, both qualitatively and quantitively. To deal with and respect both rivers, it will not be enough to predict which way things will change; there will be a definite need to know how much change and for what reasons.

Response: Concur. The St. Louis District plans to conduct ongoing studies of the effect of operation and maintenance procedures of the 9-foot channel project on the riverine ecosystems.

Comment 8: When completing an environmental review one basic question always remains. How will the statement be used? Hopefully, this environmental statement will not only shape existing but the future projects so all development plans and proposals will be responsive to the environmental problems and concerns of the people most directly affected.

Response: The reader should refer to the Statement of Findings which spells out the position of the St. Louis District and Corps on the needs for future study.

j. UNITED STATES DEPARTMENT OF TRANSPORTATION FEDERAL HIGHWAY ADMINISTRATION REGION 5. (Letter dated July 23, 1975)

Comment 1: As requested, we have reviewed the Draft Environmental Statement prepared by your office for the Operation and Maintenance of Pools 24, 25, and 26, Mississippi and Illinois Rivers and have no comments to offer on the proposed undertaking.

Response: Comment noted.

k. DEPARTMENT OF TRANSPORTATION--REGIONAL REPRESENTATIVE OF THE SECRETARY - KANSAS CITY, MISSOURI. (Letter dated August 29, 1975)

Comment 1: Our review of the Corps of Engineers' Draft Environmental Statement covering the Operation and Maintenace of Pools 24, 25, and 26, Mississippi and Illinois Rivers, indicates that the Statement adequately considers the effects the project may have on areas within the jurisdiction of the Department of Transportation.

Response: Comment noted.

1. DEPARTMENT OF TRANSPORTATION UNITED STATES COAST GUARD
(Letter dated September 9, 1975)

Comment 1: This is in response to your letter of 7 July 1975 concerning a draft environmental statement for the Operation and Maintenance of Pools 24, 25, and 26, Mississippi and Illinois Rivers.

The Department of Transportation has reviewed the material submitted. We have no comments to offer nor do we have any objection to this statement.

The opportunity to review this draft statement is appreciated.

Response 1: Comment noted.

m. ILLINOIS ARCHAEOLOGICAL SURVEY. (Letter dated August 26, 1975)

Comment 1: The archaeological statement on page 189 as applies to the Lower Illinois River Valley is acceptable at this time since an archaeological survey is currently being conducted along the shoreline. The final EIS, however, should indicate the effect of future dredging and disposal sites upon the archaeological resource base in the Lower Illinois Valley and what efforts will be undertaken to preserve the existing archaeology.

Response: See Response 16, United States Department of the Interior.

Comment 2: The archaeological statements on page 188 as applies to the Upper Mississippi Valley are not acceptable. This paragraph begs the question about any extant archaeology by indicating that revetments would cover archaeological sites (implying that therefore they would be protected) and indicating that sites found along shorelines that erode in revetment areas would erode as a natural process and therefore the impact of the revetments on such sites is problematical. In no way does this statement, the archaeology is eroding anyway.

Response: No new revetments are planned along these actively caving banks. Project purposes are spelled out in Part 1, Project Description.

Comment 3: I therefore recommend that a detailed reconnaissance survey be undertaken of the Mississippi River Valley in Pools 24, 25, and 26 in order to determine the effect of all disposal and revetment areas on the existing archaeological resource base. In only this way will it be possible to tell the effect of the Corps project on this cultural resource.

Response: Dredge material is not deposited overbank on the Mississippi River and revetment placement and repair has a minimal impact upon the archaeological resource base.

n. STATE OF ILLINOIS DEPARTMENT OF CONSERVATION. (Letter dated August 4, 1975)

Comment 1: My staff has completed review of the Draft Environmental Statement, Operation and Maintenance, Pools 24, 25, and 26, Mississippi and Illinois Rivers.

We feel that the section dealing with the affect of your project on the Historic, Architectural and Archeological Sites adequately takes into account the views of professionals in those fields.

This letter will serve as an acceptance by our office of the general draft statement as it pertains to the cultural environment. It does not constitute State Historic Preservation Officer "sign-off" for site specific projects covered by this statement.

Thank you for allowing us to comment.

Response 1: Comment noted.

o. ILLINOIS STATE GEOLOGICAL SURVEY. (Letter dated August 29, 1975)

Comment 1: The duscussion of Paleozoic and Pleistocene formations if factual and more than adequate. Errors in spelling on Figure 2-4 (correct spelling is CENOZOIC, MESOZOIC, PALEOZOIC, ORDOVICIAN, and ABBOTT), should be corrected for final draft.

Response: Comment noted. The appropriate changes appear in the Final Environmental Impact Statement.

Comment 2: Table 2-2 showing mineral production in 1972 for counties bordering the study area may be somewhat misleading, because these figures do not indicate the potential resource of a county. For example, in the past, clay has been produced from Morgan, Pike, Green, Madison, and Calhoun Counties, and although these counties did not have production in 1972, they have the potential for future production.

Response: Comment noted. Past production has lead to the assumption that clay is a resource in the above counties. No specific data is available on the potential for future production in these counties. References: I.E. Odom, 1971. Clay and Shale Resources of Madison, St. Clair and Monroe Counties. Illinois State Geological Survey, Mineral Notes, No. 45. Urbana, Illinois.

W.A. White, 1962. Refractory Clay Resources of Illinois. Illinois State Geological Survey, Mineral Notes No. 16. Urbana, Illinois.

W.L. Busch, 1973. Illinois Mineral Production by Counties in 1971. Illinois State Geological Survey, Urbana, Illinois.

Comment 3: The geologic and soils portions of this draft could be combined to show relationships between these disciplines. For example, the geologic nomenclature could have been shown for the parent materials shown in Figure 2-16 in addition to material types.

Response: Concur. The statement did not attempt to combine the soil classifications with surficial geologic units. It was felt that the agricultural quality of the soils of the study area (see Appendix A-1) would be more beneficial to the reader because of the question of overbank disposal upon potentially productive soil units.

Comment 4: The character of materials dredged as shown in Table 10 and 11 in Appendix B, Water Quality, should be defined as to particle size and material type. It was not clear where these tables were discussed in the text. Plans for potential uses of dredged materials have a stronger case when the properties of the material are better defined.

Response: Comment noted. The data presented in Tables 10 and 11 are the best available data on dredge material at this time. It is recognized that further study is needed to adequately determine potential uses for dredge material.

Comment 5: Examination of Figure 2-5 from our Circular 478, "Geology Along the Illinois Waterway - A Basis for Environmental Planning," used the term "Sparland Formation" for "Lacon Formation." This is an error in publication for which we apologize.

Response: Comment noted.

Comment 6: Some of our reviewers felt that the draft included more geologic detail than was needed for the impact statement. We do appreciate the more concise presentation utilizing the technique of referring the reader to appendices or to the reference material.

Response: Comment noted.

p. MISSOURI DEPARTMENT OF CONSERVATION. (Letter dated September 2, 1975)

Comment 1: Page 1 - Section 1.2 - In its natural state the Mississippi River provided habitat for an abundance of fish and wildlife.

Response: Concur.

Comment 2: Page 3 - Last three paragraphs of Section 1.2.1. Side channels can fill with sediment due to natural processes, however, the last paragraph describes how this process is aggravated. The last paragraph should precede the paragraph beginning with "To alleviate".

Response: Comment noted. The text has been corrected to read in the proper sequence.

Comment 3: Section 1.2.2 - What was the impact on fish and wildlife habitat of further contractions of the river to provide a 6 foot channel?

Response: This is not known and is beyond the purposes of this statement.

Comment 4: Page 17 - Section 1.3.4 - Pages 7, 9 and 10 state that the average river width is: (1) Pool 24 - 1,900 to 2,300 feet; (2) Pool 25 - 1,800 to 1,300 feet in one reach and 2,500 feet downstream; and (3) Pool 26 - 2,700 to 1,900 feet. How, with limited pipeline can the Dredge Kennedy provide even a small degree of flexibility in selecting dredge spoil disposal sites?

Response: It is acknowledged that present plant facilities restrict the flexibility of selecting dredge material placement sites. Reference is made to Section 6.2.1., Open Water Placement, Selective Placement, paragraph 2; where an initial attempt was exercised at supplying estimated cost data for the acquisition of additional plant equipment to increase the flexibility of selecting dredge material placement sites. Figure 6-3 graphically displays the function of discharge range in terms of added cost. Additional detailed study and analysis needs to be accomplished to determine the actual cost of expanding dredge plant facilities.

Comment 5: Page 42 - Section 2.1.2 - The Colorado State University report is not cited. Is it public information and available for our further review and study?

Response: The C.S.U. report was cited in the Preface of the Draft Statement but was not in final form. The final report is cited in the Preface of the Final Statement and in the Bibliography

Comment 6: Page 44 and 49 - What is the degree of accuracy of data in Table 2-3 and Table 2-4?

Response: Tables 2-3 and 2-4 were compiled from Corps surveys contained in the files of the St. Louis and Rock Island Districts. It must be assumed that the data presented is accurate.

Comment 7: Pages 42 through 54 - Information on the river in Sections 2.1.2 is of interest, however, use of uncontrolled data as a basis for estimating river changes is questionable. Is the river stage in each survey comparable? Were surveys preceded by floods or drought?

Response: Section 2.1.2.1,"The Natural River", was taken from the Colorado State University report and it is assumed that the information is accurate. The base level elevations and changes in base levels were carefully handled to conform with modern data. Such information as island surface area, river surface areas and changes in these surface areas were based on vegetation limits along the banklines, thus the measurements calculated were not responsive to flood or drought.

Comment 8: Page 66 - There appears to be an omission of "present day data" since the EIS jumps from 1929 to the future. Why, for instance, aren't 1929 data and 1968 or 1974 data compared?

Response: The impacts after the authorization of the 9-foot channel in 1930 are presented in Part 4, Impact of the Action on the Environment.

Comment 9: Page 83 - Information from 1891 indicated the river area was 65.566 square miles; almost identical to the pools in 1972.

Response: Comment noted.

Comment 10: Page 91-92 - Fishery information taken from Nord, 1962, represents the entire Upper Mississippi River, and may not be indicative of Pools 24, 25 and 26.

Response: This information by Nord has been deleted.

AD-A116 667 ARMY ENGINEER DISTRICT ST LOUIS MO F/G 13/2

OPERATION AND MAINTENANCE POOLS 24, 25, AND 26 MISSISSIPPI AND --ETC(U)

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Comment 11: Page 117 - Harvest information for Missouri whitetail deer is misleading. Since successful hunters spent less time in the field and represent only 16 percent of the hunters in the field, the total dollar value is grossly underestimated.

Response: Concur. The Final Statement has been changed in 2.2.2.6 a(1) and Appendix C, Table 28.

Comment 12: Page 151 - The point made in the last sentence concerning the impact of drought on the river system should be considered regarding Comment No. 7, above.

Response: Comment noted.

Comment 13: Page 153 - Paragraph 5 - There has been a 16 percent loss of river area in the upper portion of Pool 25. Based on a comparison of 1891 - 1973 data, there has been essentially no change in riverbed area since 1891.

Response: Comment noted.

Comment 14: Page 158 - Table 4-6. What is the validity of riverbed elevation data? Was data taken from the same locations in each survey? What is the total storage of the pools in 1972 vs. 1939?

Response: The C.S.U. team utilized hundreds of cross-sections and riverbed point elevations to present the average riverbed elevations in Table 4-6. Data may or may not have been from the same locations during each of the three time periods; the figures represent hundreds of elevations which were then averaged for each quarter in each pool. Storage capacity data is available upon request from the Hydraulics Branch, St. Louis District Office.

Comment 15: Page 161 - Section 4.1.1.4 - If some portion of the pools are not filling with sediment, how could "upstream dams have decreased the amount of sediment coming into the study reach"?

Response: It should be noted that Pools 24, 25 and 26 are the next to the last in a series of locks and dams that stretch from Alton, Illinois to Minneapolis, Minnesota. The dams upstream of the study area have acted as interceptors insofar as the downstream movement of sediment is concerned.

Comment 16: Page 164 - Paragraph 3 - We do not agree that flooding has "not changed appreciably during the period of record". Tables 4-10 and 4-11 are of interest since only one pre-dam year is in the top ten discharges (it is ranked 7th for stage and 4th in discharge). More recent years have higher stages for a given discharge.

Response: For a better understanding of the relationship between flood stage and discharge rate reference the following. D.B. Simon, et al., 1975. Environmental Inventory and Assessment of Navigation Pool 24, 25, and 26, Upper Mississippi and Lower Illinois River. A Geomorphic Study. Contract Report y-75-3. U.S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi 39180.

Comment 17: Page 169 - Paragraph 6 - With limited equipment, it is difficult to understand how spoil can be disposed in the area with least adverse impact.

Response: Dredge material placement sites are selected with respect to the least adverse impacts based on the range capabilities of present dredge plant facilities.

Comment 18: a. Page 170 - Table 4-13 - Data on cubic yards of material moved is meaningless to most individuals. In the past 12 years the amount of spoil would make a pile 3 feet deep and 270 feet wide for the entire 105 miles in the project area.

Response: Comment Noted.

Comment 19: b. Data do not indicate the fact that dredging occurs in divided channel reaches, the most important areas for fish, wildlife and associated recreation.

Response: Plates 9A-D indicate dredge cut location and the approximate placement sites for the years 1969 through 1974. Also Plate 10 gives the location of dredging activities from 1963 through 1974 by two mile increments. Reference is made to Section 4.2.1.2 of the draft statement for a detailed discussion of the impacts of dredging on the aquatic community.

Comment 20: Page 172 - Paragraph 5 - No plans for new dikes are being made. What plans have been made for improving existing dikes?

Response: None. Any future plans for improving existing dikes will be fully coordinated with the proper conservation agencies.

Comment 21: Page 179 - Last Paragraph - Dikes provide habitat for some benthic organisms. Freshwater mussels for instance, do not benefit from dikes.

Response: Concur. Statement has been changed in response to your request.

Comment 22: Page 180 - First paragraph - The value of root wads and fallen trees associated with the natural bankline is not considered.

Response: This paragraph has been expanded to cover this subject.

Comment 23: Page 184 - Last Paragraph - Recognition of the fact that the Mississippi River is dynamic is noteworthy. The Middle Mississippi River Draft Environmental Impact Statement seemingly failed to indicate that the river was a dynamic force.

Response: Comment noted.

Comment 24: Page 184 - a. Paragraph 2 of Section 4.2.3 - This paragraph is not clear. How does conversion to intensive agriculture benefit habitat diversity?

Response: If the conversion to agriculture results in large single crop fields it would not be beneficial; however, many agricultural fields on newly farmed islands are small irregularly sloped and do increase the diversity of habitats. The Final Statement will be expanded to reflect this.

Comment 25: b. Paragraph 3 - Dredged material could be detrimental to the river otter.

Response: Concur. The Final Statement has been changed to include this comment.

Comment 26: a. Page 200 - Paragraphs 2 and 3 - Dredge spoil is good for beaches, however, the problems of erosion and redeposition, plus the fact that vegetation will convert the sand beach to a wooded island should be discussed.

Response: Concur. At the time of the writing of this statement the mechanics of erosion and movement of sediment both in the channel and along the banks is not completely understood and is certainly an area for future studies.

Comment 27: b. We disagree that dredge spoil "will have minor effects on aquatic communities". The elimination of aquatic life, freshwater mussels, or other benthic organisms is of concern.

Response: The impacts on aquatic communities mentioned in Section 4.2.1.2 Maintenance Dredging and Disposal of Dredged Material, b. Disposal, are very severe in areas affected.

Comment 28: A discussion of the following points should be included: (1) the lack of the necessary equipment to make the best use of dredge spoil; (2) dredge problems occur most often in divided flow reaches, the areas of most significance to fish, wildlife and associated recreation. Without equipment to properly place dredge spoil, the discussion of beneficial uses is incongruous.

Response: See responses #4, #17, and #19.

Comment 29: c. The last paragraph of Section 6.2.3 is somewhat incompatible with page 114.

Response: The incompatibility of wildlife use of sandbars and their development for intensive recreational use is recognized in the last paragraph of Section 6.2.3.

Comment 30: Page 201 - First complete paragraph - If sand and gravel companies were given an opportunity to bid on dredged material, it might alleviate their loss of business and provide some revenue for the Federal Treasury.

Response: At the present time, there are no specific mechanisms for the acquisition of dredged material by private firms such as sand and gravel companies. The economic use of dredge material is predicated in part on material characteristics, supply and demand, end uses and transport limits. This type of data is not currently available and therefore further study needs to be accomplished to determine the feasibility of offering dredged material for sale.

Comment 31: Page 203 - a. Last Sentence of Section 6.2.7. What is the basis for the statement that the biological life may not be significantly affected by removing dredged material?

Response: By this statement, it is meant that the quantity of dredge material removed from the floodplain by dredging would be insignificant when compared to the total amount of sediment being washed into the river by tributaries and runoff. Runoff is the major cause of siltation in backwater areas. The removal of dredge material from the floodplain would not necessarily lengthen the life of the pools.

Comment 32: b. Section 6.3.1. If laws are limiting the flexibility of operation, can't they be changed?

Response: Yes, laws can be changed.

Comment 33: c. Section 6.3.2. If increasing the pool level will reduce sediment transport, how can the data showing no change in the bottom elevation of the pools between 1929 and 1970 be valid?

Response: The data is valid insofar as high water has a tendency to flush out the main channel thereby resulting in a relative river bed elevation balance in the pools.

Comment 34: Page 204 - Section 6.3.3. What is the purpose of the pool fluctuations discussed in this section?

Response: To illustrate how fish and wildlife habitat may be varied in population; pool fluctuations were discussed as a management tool.

Comment 35: Page 206 - Paragraph 4 - The primary impact on fish and wildlife is the placement of spoil and conversion of water areas to relatively sterile sand bars. When the material moves, secondary impacts and tertiary impacts occurs.

Response: Concur, these impacts are mentioned in the first sentence of that paragraph.

Comment 36: Page 207 - a. What specific law is cited in the first complete paragraph?

Response: "Fish and Wildlife Coordination Act of 12 August 1958, P.L. 85-624, 72 Stat. 563, 16 USC 661-664 as amended.

Comment 37: b. The placement of dredge spoil is a short term benefit to recreation. Sandbars grow up in willows, erode away, and the river is narrowed and made less desirable for all uses in the long term.

Response: Many of the beaches are replenished as needed and are long-term recreation areas, e.g., Royal Landing.

Comment 38: Page 208 - Paragraph 3 - The project does encourage development of commercial and industrial facilities, which often leads to a further loss of water quality, habitat and lands dedicated to fish, wildlife and recreational uses.

Response: Concur, this point has been clarified. (See page 217).

q. MISSOURI DEPARTMENT OF NATURAL RESOURCES. (Letter dated August 5, 1975)

Comment 1: 1) Dredging activitiescan destroy underwater archaeological sites such as sunken boats, steamboat wrecks, or boats involved in Military operations during the Civil War, etc. Hence, if such a wreck is found during dredging projects, the Corps of its subcontractors should cease operations and notify this office.

Response: Dredging activities have been in progress since 1930 to maintain a navigation channel. To date, there is no record of any underwater archaeological finds within the present navigation channel alignment. Should such an archaeological find be discovered due to dredging for the purpose of navigation channel realignment the proper agency(s) would be notified.

Comment 2: 2) If the construction of bankline revetments or dikes involves disruption of portions of the shoreline, these areas must be professionally evaluated prior to ground disruption activities.

Response: There are no new revetments planned by the St. Louis District on the Upper River, however, if construction occurs in the future, the proposed disturbed land will be evaluated by a professional archaeologist.

Comment 3: 3) If the construction or repair of bank revetments covers an area where old soil has been previously deposited, an evaluation of the specific area would not be necessary, provided the disturbance does not extend to previously undisturbed or modified areas.

Response: Comment noted.

Comment 4: 4) There are no sites listed on the National Register of Historic Places which will be affected by this project. There are several sites listed on the Register within 1 - 4 miles of the Mississippi River, but none is in the direct impact area.

Response: Comment noted.

r. SOUTHERN ILLINOIS UNIVERSITY - CARBONDALE, ILLINOIS COOPERATIVE WILDLIFE RESEARCH LABORATORY. (Letter dated July 10, 1975)

Comment 1: Summary Sheet: 3.a. Paragraph 4. This statement on dikes and revetments totally ignores the adverse effects on terrestrial organisms as delineated in the text.

Response: The statement in question has been reworded.

Comment 2: You neglected to request comments from those individuals best qualified to discuss the environment--the professional biologists who have researched the plants and animals. Environmental groups like Audubon and Sierra Club are primarily unprofessional people interested in the environment.

Response: The draft environmental statement, as well as this final statement, is made available to the appropriate federal and state agencies having trained professional biologists on their staffs. Such agencies include the U. S. Fish and Wildlife Service, Forest Service, Soil Conservation Service, Environmental Protection Agency, and the State Department of Conservation. In addition to this technical review process, all educators and/or researchers who have expressed an interest in a project are forwarded copies of such statements for their review and comment.

Comment 3: Page 185. Paragraph 2. This paragraph does not hold the connotation I meant it to have. The original paragraph read "Indirectly, the navigation dams have been detrimental to wildlife by increasing barge traffic capacity on the rivers. Locking accidents by commercial carriers of toxic and flammable cargoes have produced pollution. The pumping of waste materials from vessels into the rivers is still a common practice and is difficult to detect. In addition, wave action from barges causes bank erosion and substantial water elevation changes in tributaries."
I hope you are not naive enough to believe the barges when they say they don't do it. There is a definite environmental problem there, and your paragraph just glosses over it. As you well know, it is often these minor points that get you into trouble.

Response: The paragraph referenced in the draft environmental statement now appears as the third paragraph on page 190 of this final environmental statement. This paragraph has been reworded to clarify the District's position. For the benefit of our other reviewers it should be pointed out that this review comment is referring to information submitted by Ms. Terpening while under contract with the St. Louis District. Such information is carefully edited before being included in total, or in part, in any official document released by the District. Consequently, the conclusions presented in this final environmental statement are those of the St. Louis District and not necessarily those of any contractor.

Comment 4: Basically, I am disappointed with Environmental Impact Statements. They cover the material but don't say a damn thing. Thank you for the opportunity to express my opinions.

Response: Comment noted.

8. UNIVERSITY OF MISSOURI - COLUMBIA--COLLEGE OF ARTS AND SCIENCES ARCHAEOLOGICAL SURVEY. (Letter dated July 16, 1975)

Comment 1: This statement regarding the impact of operation and management of archaeological resources seems to be in order and has considered the archaeological resources to be found in the area, especially in the Missouri region of this reach of the Mississippi River. I agree that the statements on impact of dredging materials on archaeological sites is important and am pleased to know that such materials are not deposited on the bank along the Mississippi and the Missouri.

Response: Comment noted.

Comment 2: Your reference to work by Denny, 1975, I fail to find mentioned in the bibliography and would be interested to have a copy of such material deposited with the Archaeological Survey to give us information on survey work conducted in Missouri for future reference. I also suggest that that reference be included in the bibliography.

Response: Denny, Sidney, 1975, "Arch. Survey of the Floodplains Upper Mississippi and Illinois Rivers (Lock and Dam 26 Study Area), Appendix F, Lock and Dam 26 Environmental Statement (Supplement). This entry has been placed in the bibliography.

t. CITY OF ST. LOUIS DEPARTMENT OF PUBLIC UTILITIES WATER DIVISION. (Letter dated July 15, 1975)

Comment 1: The St. Louis Water Division has no objections to offer. This will not effect the quality of the river water at our point of intake.

Response: Comment noted.

u. ADVISORY COUNCIL ON HISTORIC PRESERVATION. (Letter dated September 3, 1975)

Comment 1: Under Section 800.4(a), the Corps of Engineers is responsible for identifying archeological sites located within the area of the undertaking's potential environmental impact that are eligible for inclusion in the National Register of Historic Places. In this regard, we request that if the construction of bankline revetments or dikes involves disruption of portions of the shoreline, these areas be professionally surveyed by the Corps.

Response: Concur. In these instances where operation and maintenance activities will involve a disruption of the river and ground surface, an archeological survey of the area to be affected will be accomplished. The survey will follow the spirit and intent of EO 11593, and if appropriate the Council's procedures (36 CFR, part 800) will be followed in determining the significances of sites, and in reaching decisions as to their disposition. The environmental statement has been changed in sections 2 and 4 to reflect this information.

Comment 2: In addition, we support the August 5, 1975, position of the Missouri State Historic Preservation Officer concerning protection of unknown underwater archeological resources that may be affected by the proposed undertaking.

Response: Concur. In the event underwater archeological resources are encountered during dredging operations, relevant information will be transmitted to the appropriate state historical authorities.

Comment 3: Until archeological resources in the project area have been identified and the need for further compliance with the Council's procedures has been ascertained, the Council cannot comment favorably with respect to your environmental statement.

Response: We feel that the changes that have been made in the environmental statement regarding the inclusion of archeological survey and appropriate follow-up articles in standard operation and maintenance procedures which satisfy laws concerning the preservation of cultural resources.

v. AMERICAN FISHERIES SOCIETY, MISSOURI CHAPTER (Letter dated September 2, 1975)

Comment 1: This statement is relatively well written, although marred by wordiness and redundancies. It presents an interesting account of the historical development of control works to facilitate navigation on this portion of the Mississippi River. Much space is taken up with economic and sociological detail, apparently aimed at justifying the need for commercial navigation on the river. Since the 9-foot channel was authorized by Congress and since this statement should be concerned only with the effects of the project on the environment, such justification seems superfluous and out of place.

Response: Comment noted. In this operation and maintenance statement there is not "much economic and sociological detail" nor is the statement an attempt to justify the 9-foot channel project which is authorized by Congress.

Comment 2: Justification is needed in other areas, however. Why is it necessary to spend millions of dollars on operation and maintenance on these three navigation pools at this time? The structures to be repaired were installed to control the free flowing river before the locks and dams were built in the mid-30's. It was not deemed necessary to repair the structures in the 30-odd years between impoundment and 1969. Since 1969 a movement has been underway to rehabilitate the old dikes and revetments and an average of $4,577,000 annually has been expended in the past five years. The need for this maintenance work has not been adequately justified.

Response: Until the creation of the River Stabilization Branch, SLD, December 9, 1968, the repair of revetments in Pools 24, 25 and 26 was neglected for over 30 years. During the time period 1969-1974 three dikes and most of the shoreline revetments have been repaired. This repair work is considered a normal part of operation and maintenance procedure in securing a 9-foot navigation channel as authorized by Congress.

Comment 3: Of the alternatives presented, that of ceasing all operations and maintenance appeals most to us. The effects on the environment would generally be to the good. It is unlikely that recreational use would decrease, rather it probably would increase as the habitat returned to a more natural state and the hazards associated with commercial traffic decreased. We recognize, however, that this is not a real alternative. Navigation is a long established use of the Mississippi River, various phases of the navigation project has been authorized by Congress, so the barges will continue to run and the dredges to dig.

Response: Comment noted.

Comment 4: Dredging and the deposition of dredge spoil, without doubt, have the most serious environmental impacts of any of the activities covered by this statement. Some dredging apparently is necessary if a navigable channel is to be maintained. This is one of the most expensive aspects of channel maitenance and, since large quantities of sandy material have to be moved considerable distances, the deposition of dredge spoil is also expensive. Anything which tends to increase the distance the spoil must be moved,increases the cost. These simple facts, however, are never clearly stated in the statement.

Response: Disagree. This point was clearly stated in Section 6.2.1 Open Water Placement, Selective Placement.

Comment 5: Several alternative methods of dredge spoil placement are presented in Section 6.2 of the statement. One of these is to equip the present dredges with additional facilities so that spoil can be placed selectively. It is estimated that it would cost $977,000 for additional equipment and $432,000 annually in additional operating costs to increase the length of the discharge pipe of the dredge "Kennedy" from its present 850 ft. to 1,900 ft. Other alternatives cited possibly are more costly since most would require movement of spoil for greater distances. No cost estimates are given, however, so comparisons can not be made. Many of the alternatives have desirable features which might offset higher costs but without cost estimates it is difficult to make a judgement. Thalweg placement (6.2.2) seems to have much to recommend it but cost estimates are missing and apparently more research is needed to acertain downstream effects.

Response: Comments noted. Additional cost data has been added on page 208. Thalweg placement research is in the math model stage and no decision has been made to pursue further studies of this alternative.

Comment 6: It seems to be implied in Section 6.3 that fluctuations in pool water levels could make unnecessary much of the dredging now being done. This alternative is not adequately explored, possibly because of limitations imposed by the "Anti-Drawdown Law". Of course, pool level fluctuations have far reaching effects, not only in the river but in the neighboring flood plain and all of these need to be taken into account. It is not possible, however, to evaluate the alternative from the meager information provided.

Response: The Draft Statement, Section 6.3, does not imply that pool water levels could effect dredging. The notation of the "Anti-Drawdown Law" in the Draft was in error and has been revised for the Final Statement.

Comment 7: The alternative section (6) of this statement is unsatisfactory. At least one alternative presented is not really an alternative. Use of the Mississippi River for commercial transportation and maintenance of a navigation channel by the Corps of Engineers are long established practices and not likely to be changed. Therefore, abandonment of all maintenance and operational work is not a real alternative. As has been pointed out, it is impossible to evaluate alternatives unless estimates of their cost and full research into their effects are presented. This has not been done. We recommend that this section be rewritten to present real alternatives in such a manner that realistic judgements among them can be made.

Response: The alternatives to the Action, Section 6, portion of the Statement addresses those alternatives which seem most practical at this time. The Statement of Findings addresses those alternatives which in the opinion of the Corps are feasible and warrant further study.

Comment 8: The statement deals with spills of deleterious substances (petroleum products, toxic chemicals, etc.) in a very superficial way. Spills are a very real hazard of modern freight hualing and they can be especially damaging when they occur on a waterway. For these reasons the subject should be thouroughly treated in an environmental impact statement. The type, frequency, magnitude, and environmental damage of past spills should be enumerated. Accidental spills probably can not be prevented on a stream used for commercial navigation but resulting damages can be greatly reduced if proper measures are taken to prevent occurrence and effective methods are used to contain and clean up those that do occur. The statement should present a review of precautionary measures in effect to prevent spills when loading and unloading deleterious substances at each port and of plans to contain and clean up spills in each reach of the river, including responsible agencies, and equipment and personnel available for the purpose.

It is well known that a large number of the spills which occur on a navigable stream such as the Mississippi River are deliberate dumpings of unwanted cargo. This may be done to lighten a grounded barge, to rid barges of residues of the last cargo in preparation for the new, or any number of reasons. The statement passes over these lightly with the comment that they are illegal. This is true, of course, but they occur because the stream is used for navigation and because many of the barge operators choose to flout regulations. The fact that the spills are the result of illegal activity does not lessen the damage done to the environment. This statement would be much more palatable to environmentalists if it contained some indication that the commercial barge lines were making a serious attept to police themselves to prevent this type of illegal activity.

Response: The Coast Guard has rules and regulations pertaining to spills on the rivers and is responsible for enforcing accidental and other spills. The Environmental Protection Agency has set water quality standards for deleterious substances. The Corps cooperates with these agencies and other state and local agencies as to the water quality of the rivers.

w. MIGRATORY WATERFOWL HUNTERS, INC. (Letter dated August 29, 1975)

Comment 1: Summary Sheet: Should be rewritten to include the direct effect which is allowed by the 9-foot Channel Project, namely barge traffic and its effect on the Mississippi and Illinois Rivers.

Response: The impact of barge traffic upon the river system was not addressed in this statement. In the Environmental statement: Locks and Dam No. 26 (Replacement), Supplement, the physical/biological impact of turbidity, resuspension of sediments and shoreline wave wash due to barges was discussed.

Comment 2: 1.2 This part should contain brief material which accurately conveys the social, cultural and environmental conditions of the region and their changes as the river was developed for navigation purposes.

Response: These items were adequately discussed in part 2, Existing Environmental Setting and part 4, Impact of the Action on the Environment.

Comment 3: 1.5.1 We are of the opinion that the extent to which tows have presently experienced delays at Lock & Dam 26 is more a function of the nature of the commodities being shipped rather than deficiencies in the structures.
Replacement of Lock & Dam 26 will have an effect far greater than reduced maintenance cost and reduced locking delays. It will effect the other two dams and the Illinois River portion of Pool 26.

Response: Not relevant to this document; refer to environment statements concerning replacement L&O 26.

Comment 4: 2.2.2.6a The values stated for consumption and nonconsumptive economic importance of wildlife is misleading. The economic values asserted for consumptive uses have been developed from data that is mainly objective in nature, while the data for nonconsumptive uses was highly subjective. It is a comparison of apples and oranges and should be clearly labeled as such in the text where it appears.

Response: The source of the data used to evaluate nonconsumptive economic importance of wildlife is given. It is acknowledged that little data is available to evaluate this aspect of wildlife values, but the data used is not believed to be misleading.

Comment 5: 4.1.1.3 Table 4-10 appears to show an increasing flood stage and frequency since the 9' Channel Project was implemented. No explanation is given in the text.

Response: The text states in Section 4.1.1.4, Effect on Discharges and Stages: "Analysis of Tables 4-10 and 4-11 indicates that the flood stage-versus-discharge relation at Hannibal has not changed appreciably during the period of record."

Comment 6: 4.1.4.4 Barges have been trapped or held in Pool 26 with extremely hazardous material during winter months by ice and thus subjected the residents to risk that they would not otherwise be subjected to.

Response: Comment noted.

Comment 7: 4.2.2.2 There is no indication that impacts upon migrating waterfowl and other birds of the Mississippi Flyway, in which the dams are centered, was studied. Knowledge relating to timing of dredging operations and its short term effect on waterfowl habitat for the Spring and Fall migrations, as well as long term effects, should be included.

Response: Concur. A paragraph on this subject has been added to the Final statement in Section 4.2.2.2 b.

Comment 8: 4.2.2.2c An appendix should be added which gives justification to the conclusions that Federal and State regulations "greatly reduce the amount of waste entering the waterways" from barges.

Response: No such data is available, it must be assumed that the programs of the Coast Guard and the Environmental Protection Agency are effective. Section 4.2.2.2c has been changed in the Final Statement.

Comment 9: The term "indiscriminate hunting" should be removed. Since the authorization of the 9' Channel Project, no form of hunting has materially contributed to the reduction of threatened, rare or endangered species. In addition, since the authorization of the 9' Channel Project, the adjacent states have regulated hunting so that such hunting (if it were to have existed) must have been illegal rather than indiscriminate.
A differentiation should be made in the text between those species which are rare in nature and those that are rare in the project area but occur elsewhere in abundance. Barge travel has been observed to directly affect the canvasback duck that regularly winters over in Pool 26.

Response: The term "illegal" has been added. Species have been endangered by indiscriminate hunting before the advent of laws protecting these species (some of the game laws applying to endangered species were enacted since the construction of the 9-foot channel). It is true that any hunting of an officially listed endangered species is illegal.

The species that are considered to be threatened, rare or endangered by the States and by the federal government are distinguished in Appendix C, Table 46. A paragraph has also been added to Section 4.2.3 describing the impacts to those federally listed species.

The effects of barge traffic on waterfowl is not well known. However, a statement to this effect will be added to the Final statement in Section 4.2.2. c.

Comment 10: 4.3 The project has decreased the aesthetic appeal in some of the project areas by facilitating the beaching and tieing up of barges and the operation of barge terminals.

Response: Comment noted.

Comment 11: 4.3.2b The regional economy is also affected by the recreational uses of the 9' Channel and the expenditures for personnel and equipment by the Corps of Engineers.

Response: Comment noted.

Comment 12: 4.4c One impact is clear. As a result of the 9' Channel Project large land holdings have been set aside to the benefit of wildlife and public recreation. It is not likely that these holdings would have occured otherwise. Funds of other Federal and State agencies that might have been required for acquisition purposes to meet the recreational needs of the area have been freed for use on other projects or areas.

Response: Concur.

Comment 13: 4.5 This section should be rewritten to at least contain by reference the data presented in other portions of the Draft E.S. in addition to fishing. The adverse impacts on recreation on Upper Mississippi and Lower Illinois Rivers will result in a shift of demands and costs to State agencies and the private sector which they may not be able, or prepared, to meet.

Response: The statement should not be redundant by presenting the same data in several places.

Comment 14: 6.2 We support the continued operation of these Locks and Dams. Greater emphasis must be given to the solutions or reparations made for the adverse impacts. We are aware of legal, traditional and institutional constraints which have in the past affected the St. Louis District's ability to recognize and define problems in other than navigational interest terms.

Response: Comment noted.

Comment 15: It is highly unlikely that any single alternative listed in this section would, by itself, be the solution to the adverse impacts associated with the project. Section 6.2.6 is the most desirable. As a practical matter, a combination of Selective Placement options guided by the principle of least environmental damage, improvement of recreational opportunity and greatly reduced emphasis on the cost of moving dredged materials would be an acceptable option. Ongoing studies should be made to identify areas where siltation, natural and that resulting from dredging activities, have occured which have dysfunctional effects on recreational uses such as waterfowl habitat and hunting and corrective measures taken. This should be a regular function as part of the operation and maintenance.

Response: Comment noted. The reviewer should refer to the Statement of Findings for the St. Louis District's official position on future studies.

Comment 16: 6.3.1 A study should be made of the effects of the "Anti-Drawdown Law" and the desirability of changes in that law so that the benefits of water level management may be gained for wildlife.

Response: The discussion of the Anti-Drawdown Law was in error in the Draft Statement and has been omitted in the Final Statement.

x. SIERRA CLUB - PIASA PALISADES GROUP (Letter dated August 28, 1975)

Comment 1: Citizen Interest. For several years now there has been a growing citizen interest in the poor treatment that has been afforded our nations' big rivers. The Upper Mississippi River is truly the most significant natural resource in the Midwest, yet because of inadequate long range planning and the pressures of special interest groups, the quality of the Upper Mississippi River and the tributary Illinois River has grown over the years progressively worse.

For 151 years the prime use of the rivers have been for navigational purposes and countless millions of governmental dollars have been pumped into "development" works designed to promote and facilitate navigation. No one who has read this Draft EIS would disagree that although there have been profits made by some as a result of the many navigational works, there has also been severe envirormental damage as a consequence.

It is with relief that we arrive at this point in time where some consideration is also to be given to our natural environment. River corridors provide the only natural habitat remaining in our heavily populated, industrialized and intensively farmed midwest area and the Sierra Club is determined to see that other uses of the river are given equal consideration.

Response: Comment noted.

Comment 2: As has been pointed out separately in the Sierra Club comments on O&M of the Middle Mississippi River, Congress created the NEPA Act to "reverse what seems to be a clear and intensifying trend toward environmental degradation," and they were particularly concerned about the impact on the environment by federal agencies which were by prior acts of Congress, "development-oriented"; that is, agencies which had developed over the years institutional policies which promoted economic development and new generations of technology without regard to their future effects on the environment.

The Sierra Club regrets that it took the St. Louis District more than five years to institute environmental studies as required by law on the issue of operation and maintenance of the navigational channel. Instead of devoting manpower to initiating environmental studies on the Upper and Middle Mississippi Rivers, major efforts were instead directed toward engineering studies in anticipation of construction of a new dam to replace L&D 26, reconstructing and "improving" dikes and revetments in the Upper Mississippi River reach, coordination with the Kansas City District on planning for the ill-advised Unit L-15 Levee Proposal, and so forth - the very reasons that NEPA was created by Congress. Other Corps districts in the midwest have had EIS studies under way for several years on O&M of the navigational channel.

Response: The environmental studies for the Operation and Maintenance Environment Statements were initiated in 1971; they have and will continue as is addressed in the Statement of Findings. An expenditure of over a million dollars (see Preface for a listing of studies) cannot be considered minimal.

Comment 3: General Impressions. Given that the SLD has been so reluctant to begin environmental studies, favoring instead the continuation of engineering projects, it is not surprising to find that the general tones of the EIS is merely an extension of previous commitments that are navigation-oriented. Many of the statement are openly defensive of the historical alliance between the Corps and the navigation interests. Some of the supportive data is presented in a scattered and inconsistant manner.

Response: Comment noted. The Draft Statement is an honest attempt by the St. Louis District to fully address the impacts of the Operation and Maintenance procedure. It is quite possible for a single reader to miss major points of supportive data assembled by an interdisciplinary team of experts.

Comment 4: The overriding deficiency in the DEIS is the fact that it considers navigation at a static level only for future years and fails to take into consideration the dynamic technology of the barge industry, the many proposals for increasing navigational development, and current projects now under way which promise to explode barge traffic four-fold without attempting to ameliorate subsequent environmental damage or to provide mitigation. Although this DEIS briefly addresses the advancing technology and several of the development proposals and projects are discussed, all subsequent examination and discussion are based upon the premise that increased navigation technologies and quadrupled traffic would have no effect on present O&M practices.

Response: The Lock and Dam 26 (Replacement) Supplement to the Final Environmental Statement illustrates that a twenty-five percent traffic increase would occur with the replacement of L&D 26 rather than the four fold increase which you adhere to.

Comment 5: 1. Twelve-Foot Channel. Foremost among concerns by citizens and other agencies of government is the much-feared Twelve-foot Channel Proposal. One 9-line paragraph within the two inch thick DEIS addresses - and promptly dismisses - the proposal. The Phase 1 Report - Twelve Foot Channel Proposal concluded that at this time the Upper Mississippi River above Grafton was economically unfeasible for futher study, but that the Mississippi River above Cairo, thence the Illinois River above Grafton to Lake Michigan justified additional examination. Not only would the project cause severe initial environmental damage to implement, it would drastically affect operation and maintenance practices and would multiply all of the environmental woes categorized in the DEIS. Furthermore, it must be pointed out that Congress has not de-authorized the Phase 1 Study as regards the Upper Mississippi River above Grafton. Should economic situations change and should other Corps projects (such as the Duplicate Locks Project on the Illinois River and L&D 26 Replacement, for instance) become reality, it would be a simple matter for the Corps to reactivate the Twelve Foot Channel Study again to include the Upper Mississippi River above Grafton.

It should be pointed out to the SLD that nearly 100 miles of river presently considered for the 12-Foot channel falls within the area studied

in this O&M DEIS; eighty miles of Illinois River and sixteen miles of Mississippi River. Furthermore, it has been clearly shown that the design of both the L&D 26 replacement and the Duplicate Locks Project on the Illinois have been engineered to 12-foot channel specifications paving the way for future system expansion plans. To summarily dismiss further discussion on this project as it would affect future O&M is unrealistic.

Response: The purpose of this environmental statement is to address the operation and maintenance of a 9-foot navigation project. The system-wide and local impacts which are directly attributable to other projects, such as to a 12-foot channel project, are properly addressed during the time in which these projects require an environmental assessment.

Comment 6: Totally missing in the DEIS is any mention of an active Corps proposal the Year-Round Navigation Proposal. Perhaps the SLD has forgotten that the Phase I Report has been available for some time and in fact, public hearings were held in the Spring of 1974 at Rock Island and Quincy, Illinois on the issue. Virtually all of the Navigation Pool 24, 25 and 26 falls within the study area of this proposal and adoption of this plan would greatly affect O&M of the Upper Mississippi and Illinois Rivers.

O&M expenses would increase, increased dredging would become necessary, adverse environmental damage would result and navigation itself would again increase. Perhaps it is appropriate to quote from the Phase 1 Report, Mississippi River Year-Round Navigation: "...continuous navigation activities would definately increase turbidity. It is conceivable that such increased turbidity could alter the physical and chemical composition of water under the ice. This factor may represent the greatest detrimental effect."

If increased turbidity was possibly the greatest concern environmentally, the greatest concern to the SLD in terms of O&M would be how to keep the channel open. Channel bubblers to raise the warmer water to the surface, ice breaker cutter ships, hot water lines in the locks, propane-fired "cannons" to break the ice, and specially designed heating rods to keep the ice from freezing solid were some of the proposed technological solutions to the problem.

The Sierra Club regards the omission of this damaging active proposal from the DEIS as totally unwarranted.

Response: A discussion of the status of the year round navigation proposal has been added to this final environmental statement. The reviewer is referred to Part 1.5.3, page 23a.

Comment 7: In the same vein as the proceeding discussion, it should be pointed out to the SLD the omission from the DEIS of any discussion on the Duplicate Locks Project on the Illinois River. This authorized, but unfunded project would have extensive impact upon O&M of the channel within Navigation Pools 24, 25 and 26. It is puzzeling that no mention of this major authorized project was made in the DEIS. The intended purpose of the Duplicate Locks Project on the Illinois River is to encourage expanded navigational use of this

waterway in annual tonnage. The means of increasing tonnage is to deepen the locks for deeper draft barges and to provide longer locks to permit longer tows and decrease locking time.

Attendant with the increased barge traffic resulting from development of the Duplicate Locks Project are the consequences of further degradation of the riverine environment: increased commercialization and industrialization of the flood plain, water and air pollution, dredging complications, revetment and dike construction, wave wash, increasing turbidity, increased incidences of spills and collisions - the whole gamut of guaranteed consequences of concern by citizens and governmental agencies dedicated to protection of the rivers from environmental degradation.

Response: The projects which are discussed as related projects in Part 1 of this environmental statement have been limited to those which include Pools 24, 25, and 26 as part of their project boundaries. A discussion of the system-wide and local impacts which are directly attributable to other projects outside of this statement's project area are properly addressed during the time in which these projects require an environmental assessment.

Comment 8: Locks and Dam 26 (Replacement) Proposal. This active proposal by the Corps is not an authorized project but has been briefly discussed in the O&M DEIS. The discussion allocated to this proposal in the DEIS, however, is grossly inadequate considering the major impact that this project would have on future operation and maintenance of the navigational channel. Once again, this exhibits the fact that the Corps has considered the O&M of Navigation Pools 24, 25 and 26 from a historical, or "looking backwards" viewpoint rather than a forward outlook which is plagued with a host of governmental subsidized projects intended to benefit one special interest group.

Numerous Corps documents and trade publications of the navigation industry have made it clear that the purpose of replacing L&D 26 is to provide increased depth for the channel so that a 12-foot channel would be effected. Design Memorandums for L&D 26 indicate a sill depth being designed into the proposed structure of 18 feet.

> "A 12-foot channel project must have a minimum depth of 15 feet over lock sills to provide adequate vessel clearance for efficiency and safety of operations." 1

The effects of deeper draft barges, increased barge technology (including recent 10,000-plus horsepower tugs), quadruples traffic, year-round navigation, and general governmental subsidized growth patterns which detrimentally affect existing land uses has been hurriedly glossed over in this evaluation of O&M environmental impact.

Response: The purpose of this Environmental Statement is to address the Operation and Maintenance of the 9-foot navigation channel. The system-wide and local impacts of Lock and Dam 26 (Replacement) are discussed thoroughly in the Final Environmental Statement and Draft Supplement on that topic. Again, it should be mentioned that the L&D 26 project is expressively designed for 9-foot navigation purposes.

Comment 9: Lake Michigan Water Diversion. Yet another impending proposal which would have adverse environmental consequences within Navigation Pool 26 is the current study to divert additional waters from Lake Michigan through the Chicago Saritary and Ship Canal and subsequently into the Des Plains and Illinois Rivers. The proposal would increase the present 3,200 cubic feet per second of water that is artificially discharged into the Chicago River to be increased to 10,000 cubic feet per second. No mention of this possible project was examined in the DEIS contrary to NEPA regulations which require consideration of related project works. Permanently increasing the rate and volume of flow may have major impact on environmental aspects.

Response: See response to Comment 7.

Comment 10: Summary of Deficiencies Relating to Future Project Works. Five projects described above are either inadequately dealt with or are totally omitted from discussion in the DEIS contrary to NEPA regulations. Each of the above have major impacts on O&M of Navigation Pools 24, 25 and 26 if they are carried out. Each of the above proposed projects will lead to increased degradation of natural resources within the Mississippi and Illinois Rivers - both in the study area and throughout the entire system, if implemented. As in previous Corps documents and project proposals, this DEIS attempts to isolate the immediate study area or specific project as a singular development having no association with other reaches of the river or with other proposed public works and management projects.

Several legal injunctions have been recently entered against Corps projects because there had been a reluctance to evaluate entire river systems as a whole rather than evaluating each engineering works or management plan as a separate and isolated impact. It should be painfully clear to the SLD by now that engineering projects and O&M programs must be evaluated as a system whole.

Response: See responses to Comments 5-9.

Comment 11: Specific Deficiencies. There are a number of areas within the DEIS that are incorrect and while we believe there is no deliberate attempt at misrepresentation, they are indicators that additional studies should be continued so that the public and other governmental agencies have all of the correct facts.

1. Par. 1.3.1.1 Navigation Pool 24. Page 7.

DEIS: "Three state parks and recreation leases have been granted to the State of Illinois."

Comment: There no lands within the Navigation Pool 24 area of Illinois designated as state parks.

Response: There appears to be a misunderstanding on the part of the reader as to the intent of the terminology used in the Draft Statement. The areas refered to are river access areas designated as park and recreation leases granted to the State of Illinois. They are not state parks nor was it the writers intent to represent them as such. The Final Statement has been altered to read accordingly.

Comment 12: 2. Par. 1.3.1.2 Navigation Pool 25. Page 9.

DEIS: "In addition, there are four state park and recreation leases - Titus Hollow and Red's Landing in Illinois,..."

Comment: There are no lands within the Navigation Pool 25 area in Illinois designated as state parks.

Response: See Response 11.

Comment 13: 3. Par. 1.3.3.3 Navigation Pool 26. Page 13.

DEIS: "There are numerous private marinas as well as eleven state park and recreation leases; ten in Illinois and one in Missouri."

Comment: There is only one area within Navigation Pool 26 area designated as a state park - Pere Marquette State Park in Illinois.

Response: This is an accurate observation. See Response 11.

Comment 14: 4. Par. 1.3.4 Maintenance Dredging. Page 17.

DEIS: "To maintain a minimum 9-foot navigation channel, dredge cuts are usually made to a depth of 9-feet below the minimum pool elevation. A two foot over-depth is made to provide for any subsequent siltation;... In addition, proper clearance must be maintained between the bottom of the tow and the channel bed to prevent excessive drag forces and possible groundings."

Comment: No reference is made as to what the additional "proper clearance" requirements are. Are the proper clearance requirements one foot or more? Corps reports on the Year-Round Navigation Proposal and EIS reports on the L&D 26 replacement contend that a 9-foot build-up of ice on the bottom of barges in the winter is commonplace. Does occurance, if factual, justify an additional dredge cut of 9 feet to provide for "proper clearance"?

Response: Ice build up on the bottom of barges does not predicate additional dredge cuts beyond the authorized 9-foot navigation channel plus a two foot over-depth.

Comment 15: 5. Par. 2.1.2 River Channel Configurations. Page 45.

DEIS: "For example, a portion of the Mississippi River floodplain along the left bank opposite Hardin, Illinois...."

Comment: Hardin, Illinois lies between mile 20 and mile 25 on the Illinois River - not the Mississippi River.

Response: The statement in question is perfectly correct. If the reader had continued through that entire paragraph, he would have noted reference made to Gilead Island which lies due west of Hardin, Illinois across the entire width of Calhoun County on the left bank of the Mississippi River. This area is easily located on the Corps of Engineers Navigation Chart # 44 approximate River Mile 250.5.

Comment 16: 6. Par. 2.4.2 General Patterns of Land Use. Page 140.

DEIS: "(Navigation) Pool 26 begins at Alton, Illinois, and stretches in a due north direction to Winfield, Missouri."

Comment: For the benefit of the engineers from the St. Louis District, the Mississippi River flows from west to east in this portion of the study area. Winfield, Missouri is almost due west of Alton, Illinois.

Response: Comment noted. Thank you for pointing us in the right direction. Text has been changed to read accordingly.

Comment 17: 7. Figure 4.5 Recurring Dredge Cuts. Page 171.

Discrepancies exist in the data offered in Figure 4.5 and in Plate 9-A. Figure 4.5, for instance, indicates that there was dredging necessary at mile 208 (off Piasa Island on six occurances between 1964 and 1974.) Plate 9-A, however, indicates that there has been no dredging at all at this location between 1969 and 1974.

Assuming only one dredging is necessary per year, this means that according to Fig. 4.5 data, there were one-half million cubic yards of material removed from the channel and spoiled on or near Piasa Island for five consecutive years - 1964-1968. Furthermore, the data shows that the dredge Kennedy had to return to mile 208 for a second time during one year of the 1964-1968 period and perform additional dredging - this time removing one-quarter of a million cubic yards of the material.

Data supplied by the Corps in Plate 9-A shows that during the next six years it was not necessary to visit the site at all. This suggests to the reader of the DEIS several possibilities:

1. The data shown in Figure 4.5 is in error, or

2. The data shown in Plate 9-A is in error, or

3. Both Figure 4.5 and Plate 9-A is in error, or

4. Severe over-dredging was performed during the years 1964-1968 in violation of the authority granted by Congress in the Rivers and Harbors Act of 1927, or

5. "Make work" dredging was performed unnecessarily during the vears 1964-1968 at mile 208 just to keep equipment busy.

It is simply not credible to maintain that it was necessary to remove two and three-quarter million cubic yards of material at one dredge site on six occurances in a five year period, and then find it unnecessary to remove one grain of sand from that site over the next seven years. (No dredging has been performed here in 1975 either.)

Response: This discussion of recurring dredge cuts, of which Piasa Island (RM 208) is referenced, indicates a complete misunderstanding of the data presented in the Draft Statement. Your calculations of the data eluding to the fact that 2.75 million cubic yards of material was dredged at RM 208 is erroneous.

In 1966, there was a large ice jam in Pool 26 which extended upstream into both the Mississippi and Illinois River. When the ice was finally freed, it released a large bed load into the vicinity of RM 208. The material created an extremely large sand bar within the navigation channel. The dredge Ste. Genevieve was dispatched to this location in April 1967, to initially remove a portion of the sand bar. Subsequently, in June 1967, the dredge Kennedy was dispatched twice to this location to complete dredging of the navigation channel. Dredging depths did not occur beyond the 2 foot over depth which is standard procedure. The total amount of material dredged at Piasa Island (RM 208) during 1967 did not exceed 335,100 cubic yards. Total material dredged at Piasa Island during the period of record (ref. Plate 10) did not exceed 500,400 cubic yards.

No channel maintenance dredging has occured at RM 208 since the 1967 dredging season.

Comment 18: Par. 4.2.1.3 Operation and Maintenance of Locks and Dams. Page 182.

A. A number of references within the DEIS boast that the dams within the study area have created more aquatic habitat than existed prior to the construction of the navigation dams.

B. DEIS: "Increased recreation potential has resulted due to the greater water surface area within Pools 24, 25 and 26," is stated in Par. 1.3.3.3 (Page 10); and"the general effect of operation and maintenance of locks and dams on the aquatic communities of (Navigation) Pools 24,25 and 26... has been quite favorable. The aquatic habitat has been increased both in area and diversity."

C. Comment: Evidence presented elsewhere in the DEIS, however, does not substantiate the numerous claims. Data exhibited in Table 2-4 reflects figures of Navigation Pool 25 which were obtained during the Brown Survey and show that there were 22.454 square miles of surface water in 1891, whereas in Chapter 4, Table 4-3, total surface water areas is found to be only 22.562 square miles in 1973 - an increase of slightly over .1 square miles.

The questions which naturally arise to the reader of the DEIS are:

1. Is the data presented in Table 2-4 inaccurate?, or

2. Is the data presented in Table 4-3 inaccurate?, or

3. Is the data presented in both of the above tables inaccurate?, or

4. If both tables contain accurate data, then an increase of .1 square miles over an 83-year period certainly does not appreciably increase aquatic habitat.

D. Furthermore, extirpation of 18 species of fish from the Illinois River and 8 species from the Upper Mississippi River - at least partially attributed to prevention from upstream migrations due to construction and operation of dams - is not the Sierra Club's impression of "quite favorable" operation and maintenance.

Response:

A. If the Sierra Club reviewer wishes to argue with the three experts cited on page 182 he is perfectly within his right, but these persons cited are assumed to be specialists within their fields and the St. Louis District will still consider their opinions and fieldwork to be accurate.

B. The quote stated to be on page 10 (Par. 1.3.3.3) is not located on that page.

C. Three tables are given in the Environmental Statement which show changes in surface area, (river, islands, riverbed) for the Pool 25 reach; these are Table 2-4, 1891 surface area; Table 2-7, 1929 surface area; and Table 4-3, 1973 surface area. Also, in Section 2.1.2.2, Early Developments, it was recognized that: "Compared to the early 1800's, the surface area of the Pool 25 reach had decreased by 1.3 sq. miles or 4.1 percent in 1891". This decrease was due to natural causes. Between 1891 and 1929 the area of the river decreased (man induced). After 1929 the river area increased again (by 9.3%) as a result of the construction of Lock and Dam 25. We concur that the square miles of surface water in the Pool 25 reach in 1891 and 1973 are almost the same. The baseline data for the statements that you allude to are quoted from the 1929 to 1973 increase or as a result of the 9-foot navigation project which is the item of discussion in this Statement. There is no attempt in this Statement to present

inaccurate information as each item discussed followed a logical chronological order.

D. Comment noted.

Comment 19: D. Failure to Quantify Environmental Damage. There has been no attempt to quantify the environmental damage identified in the DEIS The Corps has simply stated that there are certain irretrievable adverse impacts to the environment and has dropped it at that. The Sierra Club feels that studies must be made by the Corps to determine the extent of adverse impact that has occured or will occur if there is continued pool regulation giving specific data - not just in general recognition that there has been environmental damage.

Response: The reader is refered to the Statement of Findings for the official position of the St. Louis District on the needs for future study.

Comment 20: E. Failure to Mitigate the Environmental Damage. The Corps has not exhibited any determined effort to minimize the adverse impacts, nor are there any specific proposals evaluated within the DEIS that would minimize the environmental damages.

Response: The reader is referred to the Statement of Findings for the official position of the St. Louis District needs for future study. The reviewer should also read Sections 6.2 and 6.3.

Comment 21: F. Alternatives to the Action. The DEIS evaluates only three alternatives: that of complete cessation of all O&M activities, that of various locations for dredge disposal, and that of further manipulating pool levels. The disproportionate amount of discussion allocated to cessation of the O&M activities is typical of the scare tactics which have been exhibited by the SLD during other Corps controversies. Cessation of activities is an alternative which must be evaluated under NEPA requirements, but so are other alternatives:

1. Restrict navigational capacity on the waterway. There are finite limits to the extent that the inland waterway system can be expanded without total destruction of the natural resources. Somewhere along the road to blind expansion of navigation, there must be intelligent evaluations on how much we are prepared to sacrifice in terms of environmental degradation.

One way to minimize further damage would be to set limits on navigational expansion. Just as we have limits on capacity to many things in our lives (e.g. number of people on a bus or an elevator, number of visitors to our National parks), an alternative might be to restrict the numbers of tows to minimize turbidity, danger of collisions, wavewash, water and air pollution, etc.

Response: The extent in which the discussion of any alternative is presented in this environmental statement is not based on any preconceived decision to either "support" or "scare" the public. These discussions are presented in order to inform the public of the impacts associated with each alternative.

The alternative of restricting navigational capacity of the waterway is not within the purview of this environmental statement which is specially concerned with that of providing a 9-foot channel.

Comment 22: 2. Restriction on the physical sizes of barges should be studied as an alternative action which would minimize resource destruction and reduce O&M effort and expenses. Perhaps reverting back to barge draft of 6-1/2 feet (rather than planning for expansion to 12 feet) would be a practical alternative to present O&M practices. This aspect should be studied in detail for the Final EIS.

Response: Comment noted. The reader should refer to the response for Comment 21 (2nd paragraph).

Comment 23: 3. Restriction on the physical size and horsepower of pushboats. The steamboats of Mark Twain's day had little effect on the river as compared to the technology of man that is being applied to tugboats today. Larger and greater horsepower tugs are appearing on the Upper Mississippi River. Three boats of 10,500 h.p. have made their appearance this year and have progressed thru Locks 27 as far upstream as Hartford, Ill. Only the present sill depths at L&D 26 prevent these powerful tugs from invading the Illinois River. There must be a practical size limitation imposed so that turbidity of the river is not quadrupled along with navigation volume.

Response: See response to Comment 21 (2nd paragraph). The current minimum depth of the water over the sills at the existing Locks and Dam 26 does not prevent the navigation of 10,500 H.P. vessels.

Comment 24: 4. Restriction of navigation on certain days of the week. Navigation continues 24 hours per day without relief. Just as many zoos and natural areas are closed for one day per week to provide relief for the animals, so might a feasible alternative to the O&M be a consideration of restricting navigation for a period of time each week for recovery.

Response: See response to Comment 21 (2nd paragraph).

Comment 25: 5. Another alternative which might have been considered is the restriction of navigation during certain periods of the year. Cessation of barge traffic during periods of extreme high flows would minimize damage to banks, fields and structures of man. Excessive wave wash is a frequent complaint of river property owners due to inconsiderate barge crews.

Possibly the greatest potential alternative to O&M problems is to restrict navigation during excessive low flows. This would minimize the heavy dredging that must be carried on each year at critical channel crossovers. During normal flows, water levels can be maintained in the channels to ensure adequate depth so that barges will not "bump" on high spots on the river bottom. Turbidity problems would be minimized during those low flow periods as would the consequences of a serious oil spill during low flows. O&M efforts and costs would be dramatically reduced.

Response: See response to Comment 21 (2nd paragraph). Barge traffic is restricted during periods of extreme high flows in order to minimize bank damage.

Comment 26: 6. In summary of alternatives to O&M action, it should be clear that there other alternatives available to the Corps than those glossed over in the DEIS. The Sierra Club requests a more detailed and thorough examination and study of real alternatives.

Response: Disagree. The alternatives in the Draft Statement were not glossed over. The alternatives presented along with the Statement of Findings is an honest attempt by the St. Louis District at evaluating all the facts which apply to the Operation and Maintenance of the 9-foot Navigation Channel, Pools 24, 25 and 26.

y: THE WATERWAYS JOURNAL WEEKLY. Letter dated August 29, 1975)

Comment 1: We should like to take this opportunity to commend the St. Louis District on the thoroughness of the preparations for this environmental impact statement, and the wide range of organizations and individuals who were contacted by the District prior to the publication of this environmental statement.

Response: Comment noted.

Comment 2: In evaluating this statement, we believe it is imperative to remember that in the National Environmental Policy Act, as passed by Congress, language therein is explicit that a balance should be maintained in the consideration of environmental features between the welfare of nature and man. Nowhere do we read in NEPA that Congress has given governmental agencies the authority to place the human race in "second place" when environmental considerations are made.

Response: Comment noted.

Comment 3: In reading this environmental statement, we feel that the proper balance has indeed been kept, and that the statement demonstrates a need for the operation and maintenance of pools 24, 25 and 26.

We conclude that the operation and maintenance of pools 24, 25, and 26 on the Mississippi and Illinois Rivers is necessary for the human environment. An increase in population and industrialization in the next 25 years or more, regardless of the present efforts to achieve a "zero" population plateau, will result in the need of additional transportation facilities. A recent study performed for the United States Maritime Commission by the consulting firm of A. T. Kearney, of Chicago, predicts that inland waterways transportation will double by the year 2000. Based on the statistics for "Waterborne Commerce of the United States," for calendar year 1972, this would mean that 78,367,914 additional tons of freight would move on the Illinois River alone, most of which will pass through some of these pools.

In view of these factors, it would seem that the human environment in the Midwest and South needs the continued operation of these navigation pools to keep down the shipping costs for such vital materials as petroleum products, coal, grain, ores, and iron and steel products--to name a few. Likewise, in a period when balanced trade with foreign countries is of very great importance the price of grain, which is reduced through water transportation, becomes of very great importance to the country's economy.

Response: Comment noted.

Comment 4: An evaluation has been made in the environmental statement on the effects on wildlife of the nine-foot navigation project on the upper Mississippi from Alton north to the Twin Cities. It has always impressed us that because of the project a great area has been made habitable for wildlife, especially water birds, due to stable water conditions. Some 194,000 acres of backwater and marshlands were turned over by the Corps to the Bureau of Fish and Wildlife and/or the various states, for wildlife refuges, after the locks and dams were completed.

This, we would say, is a far cry from the days that thousands of fish died each year when the sloughs dried up in late summer and fall along the upper Mississippi. It will be recalled that the Fish Commission of the state of Illinois operated a steamboat to save these fish by moving them from shallow to deep water.

Response: Comment noted.

Comment 5: Dredge Spoil Disposal--Any change in bank and channel material is going to cause effects on vegetation and organisms. This has been going on for centuries through floods, bank cave-ins, and other natural forces. True, there is a temporary change in what has been coined the "ecosystems," but apparently this has not been too devastating to wildlife inasmuch as there are muskrats, beaver, and amphibians around in 1975, and many fish. Nature takes care of itself.

Response: Comment noted.

Comment 6: Noise Pollution--Comments have been made about protecting animals and birds from noise pollution through the elimination of construction of ports and terminals on the waterways. This would have a devastating effect on the future development of river traffic. Cargos moved by river must be loaded and unloaded, or there would be no river commerce at all. There are many examples of wildlife living close to industrial facilities, especially on the Gulf Coast. They have adjusted to the Gulf Coast. They have adjusted to the noise, just as humans do.

Response: Comment noted.

Comment 7: Wave Wash--Various reports that we have seen about the effect of wave wash on animals and fish that nest and breed along the river would indicate that they are intelligent enough to stay out of main channels, and that the wave wash from vessels does not generally reach the sloughs and chutes where these animals would naturally gravitate. We should also like to mention that although recreational craft are often omitted from wave wash reports, indications are that the wave wash from these vessels has more velocity and height than that from commercial vessels.

Response: Comment noted.

Comment 8: Fluctuating Water Levels in Pools--We can see no change in the present method of fluctuating water in pools. This process has been going on since the dams were built in the 1930's. It would appear that wildlife has become accustomed to changes in water levels.

Response: Comment noted.

Comment 9: Food Chain--Through natural floods and run-offs, the food chain is continually changing on the river bottom and, once again, since this turbidity has been going on for centuries, it would appear the turbidity caused by towboats, operating in the main channels, would have very little effect on the food chain necessary for wildlife. Food necessary for fish and wildlife is in the sloughs, not in the main channels of the river.

Response: Comment noted.

Comment 10: Accidents and Spillages--It should be pointed out that the pollution in the water of the Mississippi is due primarily to sewage and chemical wastes from shore, not from boats and barges. If there is one thing we are sure of, it is that the Coast Guard has been most diligent in its efforts to stop pollution on the waterways and that anyone responsible is libel to fines and even imprisonment.

Response: Comment noted.

Comment 11: Although it has been stated that secondary impacts from increased traffic on the river would cause problems for wildlife because of increased docking facilities and economic growth in the adjacent areas, it would appear to us the building of such docks and industrial areas is necessary for the maintenance of the human environment and the welfare of the human race. We should point out that even with a zero population there will be millions of young persons who will need homes, fuel, and food; much material for which is moved by river at a cheap rate and the use of less energy.

Concerning the use of the river for longer periods of time in the winter, therefore resulting in less frozen surface on the water. we would comment that we have seldom seen birds and wildlife hurt by open water, but an icy surface through which they cannot get food could cause them to perish. It would appear that barge traffic, through keeping the river free of ice, would be of great benefit to wildlife, especially birds.

Response: Comment noted.

Comment 12: We did notice one error in the Environmental Impact Statement which appeared on page 22. According to our records, the North Western Division declared that a 12-foot channel on the upper Mississippi River above Grafton, Illinois, would be economically unfeasible and asked for no further funds for this study. We believe that the word "ongoing" as used in the Environmental Impact Statement is not correct and may cause some problems in the evaluation of this report by environmental groups and the states of Wisconsin and Minnesota.

Response: Concur. Comment noted.

z. THE OHIO RIVER COMPANY. (Letter dated September 2, 1975)

Comment 1: Your subject study in general appears to be adequately extensive in all parts with the exception of Part 6 and in particular catagory (1) "cease all operations and maintenance". The most noticeable omission is the quantum monetary impact by pursuing the cessation of operations and maintenance in Pools 24, 25 and 26 of the Mississippi and Illinois Rivers. Quite frankly, this is not viewed by our industry, nor by reasonable men in other industries as a viable alternative.

Response: The "no action" alternative is in response to the Council of Environmental Quality guidelines for Environmental Statements.

Comment 2: The various economic effects suggested do not project their impact by dialogue along, and should, considering the scope of this study, be weighted by their feasibility and monetary effects. I'm sure you'll agree, the addition of this aspect in your study is mandatory to place alternatives in prospective.

Response: Concur.

aa. UNION ELECTRIC COMPANY. (Letter dated August 27, 1975)

Comment 1: Union Electric Company's Sioux Plant which houses two 452 Mw steam-electric generating units is located at river mile 209.5 on Pool 26. The present method of dredge material placement has no effect on the Sioux Plant operation. We would object ao any action which blocks the Sioux Plant circulating water intake or discharge canals, or which affects plant operation adversely.

Response: Comment noted.

Comment 2: Two of the alternatives to the present action are, cease all operations and maintenance (Section 6.1), and change pool operations (Section 6.3). Discontinuing operation and maintenance would return the river to a natural state. During dry summer periods and low-flow winter periods parts of the river would be dry or extremely shallow. Elimination of Pool 26 would result in loss or cooling water flow and shutdown of Union Electric Company's Sioux Plant, creating a power shortage in the St. Louis area, and in the upper-midwestern region thru the interconnected power system. Similarly, any significant lowering of the regulated pool (Section 6.3) would endanger operation of Sioux Plant.

Response: The guidelines of the Council on Environmental Quality specifically requires the discussion of "the alternative of taking no action or of postponing action pending further study. (Reference: Sect. 1500.8 (4) Federal Register, May 2, 1973).

bb. WISCONSIN BARGE LINE, INC. (Letter dated August 28, 1975)

Comment 1: I most heartily endorse the continued dredging and maintenance of the nine foot navigation channel in the pools as enumerated in this draft Environmental Statement. I take this position due to the information and facts which are clearly stated in this Environmental Statement.

Response: Comment noted.

Comment 2: In regards to the environment both in relation to marine life and endangered species of mammals, birds, amphibians and reptiles, I find that there isn't any threat to the aforementioned subject. In fact, your dredging in the channel is going to only cause a minimal disturbance, mostly in the terbitidy of the water Therefore, I feel that the people who are objecting the dredging and maintenance of the nine foot channel in the St. Louis District in regards to the environment and the wild life species should not be fearful of this maintenance program.

Response: Concur. The statement clearly points out those impacts which are a part of the Operation and Maintenance of the 9-foot channel project.

Comment 3: I am most heartily in favor of this maintenance and dredging program because of the economic factors that you present in this Environmental Statement. It is true that the St. Louis District is the connecting link between the Lower Mississippi River, Ohio River, Missouri River and the upper section of the country in which the Upper Mississippi River and the Illinois River are situated. The facts and figures that you present in your Environmental Statement are conclusive proof that water transportation has been an economical boon in many ways to not only the Upper Mississippi River and the Illinois Valley above the St. Louis District, but also has been instrumental in the economic welfare of the southern section of the country below your district.

Response: Comment noted.

Comment 4: I wish to compliment you and your staff upon the comprehensive and complete Environmental Statement that you have compiled. It took me a long time to read it but I must say you have been fair and presented all possible aspects to the problem.

Response: Comment noted.

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Appendices

APPENDIX A

ECONOMIC SUMMARY

Appendix A. Economic Summary. Documentation is Available at U. S. Army Engineer District, 210 N. 12th Street, St. Louis, Missouri

"Average Operation and Maintenance Pools 24-25-26"

FY 70 Through FY 74

Operation	Maintenance	Dredging
$ 1,564,700	$ 2,589,000	$ 423,300

APPENDIX A-1

SOIL INTERPRETATION SHEETS

TABLE OF CONTENTS

January 1971

USE AND EXPLANATION OF SOIL INTERPRETATION SHEETS

Each soil interpretation sheet provides information about soil properties. This information is used to determine the relative suitability of the soils for uses such as road fill, highway and street location, foundations, pond reservoir areas, embankments, terraces, cropland, pasture, woodland, wildlife, recreation, and septic tank absorption fields.

The effective use of soil ratings depends on the uniformity in terminology and criteria used in rating named kinds of soil. Soil suitability ratings and soil limitation ratings are common interpretations used in the Soil Conservation Service to express, in broad terms, the quality of a soil for a particular use.

Soil limitation ratings are used mainly for engineering uses such as foundations, local roads and streets, recreation developments, sewage absorption fields, and sewage lagoons. Ratings of slight, moderate, and severe (and in some instances very severe) are used and defined as follows:

Slight - Soils with this rating have properties favorable for the rated use. Soil limitations are minor and can be easily overcome. They may require on-site investigations.

Moderate - Soils with this rating have properties moderately favorable for the rated use. Limitations present a need to be thoroughly understood. They usually can be overcome or modified with correct planning and careful design. Areas with this rating usually require on-site investigations.

Severe - Soils with this rating have one or more unfavorable soil properties for the rated use. Limitations are difficult and usually costly to overcome or modify. A very severe rating indicates the limitation is very difficult and expensive to overcome. Deep organic soils are an example of soils that have very severe limitations for roads and streets. Areas with severe ratings require on-site investigations.

Soil suitability ratings are commonly used where general statements are needed about suitability of the soil for plant growth. They are also used to express soil suitability as a potential source of topsoil, sand and gravel, and roadfill. Ratings of good, fair, and poor (and in some instances very poor) are used except in rating the suitability of soils for wildlife. Well suited, suited, poorly suited and unsuited are used to express suitability for wildlife. Good, fair, and poor ratings are defined as follows:

Good - Soils with this rating have properties that are favorable for the rated use.

Fair - Soils with this rating have properties that are moderately favorable for the rated use. Special planning and management are needed to get satisfactory performance.

Poor - Soils with this rating have properties that, in their natural state, make them unfavorable or unsatisfactory for the rated use. Extreme and costly measures are usually necessary to overcome adverse soil features.

IMPORTANT - The following items need to be understood and considered in using soil limitation and soil suitability ratings.

1. Soil investigations, mapping, and interpretations ordinarily apply to the upper 5 or 6 feet of soil material.
2. Interpretations are based on predictions of soil behavior under defined conditions of use and management.
3. Soil ratings are based on the natural undisturbed soil for practically all uses and do not include site factors such as nearness to towns or highways, water supply, size of holding, or aesthetic values.
4. Criteria for making interpretations are based upon present knowledge and may change somewhat in the future as additional experience and data are obtained.
5. Severe or very severe ratings do not imply that the site cannot be changed to remove, correct, or modify the soil limitations. The use of soils with these ratings depends on the kind of soil limitation, whether or not the limitation can be altered successfully and economically, and the scarcity of good sites.
6. Soil interpretations do not eliminate the need for on-site evaluation by qualified professionals. The extent of on-site studies needed depends on the use to be made of the soil, the kinds of soil, and soil problems involved.

EXPLANATION OF THE INTERPRETATIONS AS ARRANGED IN SEQUENCE ON THE SHEET

Brief Soil Description - A brief description of the soil series is given in general terms.

ESTIMATED PHYSICAL AND CHEMICAL PROPERTIES

Classifications - The classifications refer respectively to the USDA, Unified and AASHO systems.

The USDA system is based on the relative proportion of various size groups of individual soil grains in a mass of soil. This system refers to the proportion of sand, silt, and clay in a soil, giving rise to basic soil textural class names, such as sand, sandy loam, loam, clay loam, silty clay loam, etc.

The Unified system of soil classification is based on the identification of soils according to particle size and distribution, plasticity, liquid limit, and organic-matter content. In this system, GW and GP are gravels well graded or poorly graded; SW and SP are sands well graded or poorly graded. SM and SC are sands

with nonplastic or plastic fines (silt and clay); GM and GC are gravelly soils with nonplastic or plastic fines; ML and CL are nonplastic or plastic fine-grained materials with low liquid limit; and MH and CH are primarily nonplastic or plastic fine-grained materials with a high liquid limit.

The American Association of State Highway Officials (AASHO) system of classifying soils is an engineering property classification. It is based on field performance of highways. According to this system, soils having about the same general load-carrying capacity and service properties are grouped to form seven basic groups. These groups are designated as A-1, A-2, A-3, A-4, A-5, A-6, and A-7. Highly organic soils (peat and muck) may be classified in an A-8 group. In general, the best soils for highway subgrades are classified as A-1, the next best are A-2, and so on with the poorest being A-7.

% of Material Passing Sieve - The measured or estimated percentages of material passing the numbers 4, 10, and 200 sieves are given for each major horizon. Where there is very little gravel-size material (No. 10 sieve) present, the percent passing the 200 sieve approximates the amount of silt and clay. Values are rounded off to the nearest 5 percent. A range is listed because of the variability for a given soil.

Permeability - Values listed are estimates of the range in rate and time it takes for downward movement of water in the major soil layers when saturated, but allowed to drain freely. The estimates are based on soil texture, soil structure, available data on permeability and infiltration tests, and observation of water movement through soils.

Available Water Capacity - The available water capacity is given in inches per inch of soil for the major horizons. Available water capacity of the soil is the difference between percentage of moisture at field capacity and percentage of moisture at the wilting point.

Soil Reaction - Soil reaction or the intensity of soil acidity or alkalinity is expressed in pH. A pH of 7 is neutral, lower values indicate acidity and higher values show alkalinity.

Shrink-Swell Potential - Indicates the volume change to be expected of the soil material with changes in moisture content.

Water Table - Either permanent or seasonal. Generally a range in depth is given at which soil saturated with water is encountered. Does not apply to soils where major subsurface drainage systems are installed.

Hydrologic Group - The soil is placed in one of four groups (A, B, C, or D) that have different runoff potentials from rainfall. Soils in group A have a low runoff potential; group B a moderately low runoff potential; group C a moderately high runoff potential; and group D a high runoff potential.

Depth To Rock - Actual ranges in depth to rock are given where they are known. Where depth to bedrock is greater than the depth required in investigation for classifying the soil, a depth greater than 6 feet is usually given.

SUITABILITY AND FEATURES AFFECTING SOIL AS A RESOURCE MATERIAL

Topsoil - The surface and subsoil horizons are rated as to their suitability for topsoil. "Topsoil" as used here refers to soil material, preferably rich in organic matter that is used to topdress back slopes, embankments, lawns, gardens, etc. The evaluation uses texture thickness, wetness, slope, and organic matter content as a basis for determining the suitability. Usually, only the surface layers of a soil are used. However, in an area dominated with sandy soils, loamy material is in great demand. Therefore, an isolated area of medium textured soil might be stripped of not only the surface layer but also the subsoil layers. It should be recognized that nutrients and structural deficiencies in the subsoil material usually need to be corrected.

Sand and gravel - Suitability as a source of sand and gravel is given for material to a depth of 5 feet. In some soils, the sand and gravel extends downward to depths much below 5 feet, whereas in other areas of the same soil, unsuitable material occurs just below 5 feet. It also should be recognized that some soils which are rated as not suitable may have sand and gravel at a depth below 5 feet. Where the suitability is in question, individual test pits will be needed.

Road fill for highway subgrade - Suitability ratings for road fill for highway subgrade are based on performance of the soil material when excavated and used as borrow for subgrade. Both the subsoil and underlying material are rated when they are contrasting in character and have significant thickness for use as borrow.

DEGREE OF LIMITATIONS AND SOIL FEATURES AFFECTING SELECTED USES

Highway and street location - The soil features considered here are those that affect the overall performance of the soil for the location of highways. The entire soil profile is evaluated, based on an undisturbed soil. The factors considered are: natural soil drainage, texture, presence of and thickness of peat or muck, depth to bedrock, presence of stones and boulders, depth to water table, stability of back slopes, susceptibility to frost heave, flooding hazard, percent slope, and shrink-swell potential.

Foundations for low buildings - The factors considered are those features and qualities of undisturbed soils that affect their suitability for supporting foundations of buildings up to 3 stories high. It is desirable that the foundation be located, if possible, below the depth to which frost may cause heaving. The suitability of the natural soil is dependent primarily on such factors as shrink-swell potential, shear strength, compressibility of the soil, susceptibility to frost heave, natural soil drainage, and depth to bedrock.

Pond reservoir areas - The factors considered here are those features and qualities of undisturbed soils that affect their suitability for water impoundment or reservoirs. Of primary concern are factors that affect the seepage rate. Such factors are permeability, depth to water table, and depth to bedrock or other material that will allow seepage.

Dams, dikes, and embankments - The factors considered here are those properties and qualities of disturbed soils that affect their suitability for constructing pond embankments, dikes and levees. Both the subsoil and underlying material are evaluated where they are contrasting in character and have sufficient thickness for use as borrow. Some of the soil features that affect construction are: stability, compaction characteristics, resistance to piping, shrink-swell potential, compressibility, and permeability when compacted.

Waterways - The factors considered in the evaluation are stability of soil material, texture and depth of soil material, natural drainage, presence of stones, percent of slope, and difficulty of establishing and maintaining vegetation.

Drainage - This column lists the factors that affect agricultural drainage. Some of these factors are natural soil drainage, permeability, depth to layers such as bedrock, fragipan, claypan or sand, topography and flooding.

Terraces and diversions - The suitability of soils for terraces and diversions depends mainly on stability, texture, and thickness of soil material, percent of slope, and difficulty of establishing and maintaining vegetation.

Irrigation - Factors affecting sprinkler irrigation are listed. These factors include intake rate of the soil, permeability, available water capacity, and percent slope.

Corrosion of concrete - Low, moderate or high corrosion potential is given for the soil. Factors affecting corrosion potential are soil texture and soil acidity, the amount of sodium or magnesium sulfate present in the soil, and the amount of sodium chloride in the soil.

INTERPRETATIONS FOR CROPLAND, PASTURE, AND WOODLAND

Cropland - Listed are the major kinds of general crops and, for some soils, a few speciality crops that are suited. Properties of the soil, such as erosion hazard, wetness limitation, climate, slope, and general fertility are items considered in the evaluation of the soil.

Pasture - Listed are the general use and suitability for pasture. Properties of the soil such as erosion hazard, wetness limitation, slope, and general fertility are items considered in the evaluation of the soil.

Woodland - Listed are the major tree species to favor in existing stands and suitable trees to plant. Available water capacity, depth to root restricting layers, and natural drainage are major factors in determining suitability of the soil for trees.

Principal soil map units - The main symbols for map units shown on soil maps are listed.

Capability class - Indicates the degree of the hazard or limitation from Class I to VIII for the use of the soil for agriculture and the nature of soil limitation; subclasses are: e - erosion; s - root zone limitations; w - wetness.

***Soil loss* - K and T factors listed for sloping** soils and are important in the use of the Universal Soil Loss Equation which provides a method for determining the various combinations of conservation cropping systems and mechanical practices that will satisfactorily control erosion. K is a measure of the rate at which a soil will erode. T is the maximum amount of soil loss in tons per acre per year that can be tolerated and still achieve the degree of conservation needed.

Yield predictions - Predictions are for a high level of management defined as follows:

High level management includes the application of effective practices adapted to different crops, soils, and climatic conditions. Such practices include providing for adequate drainage, protection from flooding, erosion and runoff control, optimum tillage, and planting the correct kind and amount of high quality seed. Control of weeds, diseases and harmful insects are other important considerations. Favorable soil reaction and near optimum levels of available nitrogen, phosphorus, and potassium are maintained for individual crops. Efficient use of crop residues, barnyard manure and/or green manure crops. All operations are combined efficiently and in a timely manner to create favorable growing conditions and reduce harvesting losses (within limits imposed by weather).

The yield information, updated through 1968, is based on the North Central Regional Research Publication 1[?] titled "Productivity of Soils in the North Central Region of the U.S." Another useful reference is "Productivity of Illinois Soils", Circular 1016, University of Illinois, College of Agriculture published May 1970.

SUITABILITY FOR WILDLIFE

Openland wildlife - Includes birds and mammals that normally frequent cropland, pasture, meadows, and areas overgrown with grasses, herbs, and shrubby growth. Examples of this kind of wildlife are: quail, pheasants, meadow larks, cotton tail rabbits and fox. Habitat elements evaluated are: (a) grain and seed crops; (b) grasses and legumes; (c) wild herbaceous upland plants; (d) hardwood woody plants.

Woodland wildlife - Includes birds and mammals that normally frequent wooded areas of hardwood trees and shrubs, coniferous trees and shrubs, or mixtures of such plants. Examples of this kind of wildlife are ruffed grouse, woodcocks, gray and red squirrels and white tail deer. Habitat elements evaluated are: (a) grasses and legumes; (b) wild herbaceous upland plants; (c) hardwood woody plants, (d) coniferous woody plants.

Wetland wildlife - Includes birds and mammals that normally frequent wet areas as ponds, streams or ditches, marshes and swamps. Examples of this kind of wildlife include ducks, rails, herons, mink, and raccoon. Habitat elements evaluated are: (a) wetland food and cover plants; (b) shallow water developments; (c) excavated ponds; (d) grain and seed crops.

LIMITATIONS FOR RECREATION

Cottages and utility buildings - These ratings apply to seasonal or year-round cottages, washrooms and bathrooms, picnic shelters and service buildings. Factors considered are: wetness and flood hazard, slope, shrink-swell and frost potential, and depth to hard bedrock. Additional items that may be considered are: suitability for septic tank filter fields, hillside slippage, presence of loose sand, and bearing capacity. Suitability of soil for supporting vegetation and whether basements and underground utilities are planned should be considered in the final evaluation.

Tent and camp trailer sites - These are areas suitable for tent and camp trailer sites and the accompanying activities for outdoor living. They are used frequently during the [illegible] season. These areas require little site preparation. They should be suitable for unsurfaced [illegible] trailers and tents [illegible] by humans, horses, and vehicular traffic. Factors considered are: wetness and flooding hazard, permeability, slope, surface soil texture, coarse fragments and stoniness or rockiness. Suitability of soil for [illegible] maintaining vegetation should be considered in the final evaluation.

Picnic areas - These are areas suitable for heavy foot traffic and used by people for the consumption of food in a natural outdoor environment. Ratings are based on wetness and flooding hazard, slope, surface soil texture, stoniness and rockiness. Ratings do not include features as presence of trees or ponds which may affect the desirability of a site. Suitability of soil for growing and maintaining vegetation should be considered in the final evaluation.

Playgrounds - These areas are developed for playgrounds and organized games such as baseball, football, tennis, badminton, and the like. They are subject to heavy foot traffic and generally require a level surface, [illegible] drainage, and a soil texture and consistence that [illegible] a firm surface. It is assumed that good vegetative cover can be established and maintained in areas where needed.

Paths and trails - This soil rating applies to areas that are to be used for trails, cross-country hiking, bridle paths, and other intensive uses which allow for the movement of people. It is assumed that these areas are to be used as they occur in nature and that little soil will be moved. Ratings are based on wetness and flooding hazard, slope, surface soil texture, stoniness, and rockiness. Consideration should be given to placement of paths and trails on sloping relief on the contour to help control erosion.

Golf course fairways - In evaluating soils for use in golf courses, consideration was given only to those features of the soil that influence their use for fairways. Greens, traps, hazards, and tees are man-made, generally from disturbed, transported soil material. For best use, fairways should be well drained and firm, be free of flooding during use periods, have good trafficability, contain a minimum of coarse fragments or stones, and have gently undulating slopes. They should be capable of supporting a good turf and be well suited for growing many kinds of trees and shrubs. Loamy soils are best, but coarser textured soils serve equally well if irrigated. Poorly drained mineral and organic soils have severe limitations but they may be used for pond sites to provide esthetic value or for storing water for turf maintenance. Sandy soils likewise may be designed for hazards or used as a source of sand.

LIMITATIONS FOR SOME OTHER USES

Residential, commercial, and light industrial development with public sewer - The ratings apply to the use of soils for residences or buildings of 3 stories or less with basements. Factors considered in making the ratings are: wetness hazard, flooding hazard, slope, limitations for foundations, depth to bedrock, erosion hazard and limitations for lawns, shrubs, and trees.

Septic tank filter fields - The factors considered are the characteristics and qualities of the soil that affect the suitability for absorbing waste from domestic sewage disposal systems. The major features considered are soil permeability, percolation rate, ground water level, depth to bedrock, flooding hazards, and slope.

Sewage lagoons - Sewage lagoons require consideration of the soil for two functions - (1) as a vessel for the impounded area, and (2) as soil material for the dam. The major features considered are: depth to the seasonal or normal water table, permeability, depth to bedrock, slope, organic matter content, flooding hazard, and the amount of coarse fragments present.

Map Symbols
Illinois - 131

ALVIN
Soil Series

MLRA 108, 110, 114, & 11[illegible] Date [illegible]/72

SOIL INTERPRETATIONS

BRIEF SOIL DESCRIPTION: The Alvin series consists of well drained to moderately well drained soils that have 0 to 1[illegible] percent slopes on uplands and terraces. They have a dark brown fine sandy loam surface layer. The subsoil is dark brown fine sandy loam or loam. The underlying material is dark yellowish-brown fine sand or loamy fine sand. Alvin soils have a low organic matter content in the surface layer, and rate to moderate. [illegible] rapid permeability, and a moderate available water capacity. Surface water runoff is slow to medium.

ESTIMATED PHYSICAL AND CHEMICAL PROPERTIES

General Soil Profile	Classification: USDA Texture	Unified	AASHO	% of material passing sieve: No. 4 (4.7 mm)	No. 10 (2.0 mm)	No. 200 (0.074 mm)	Permeability inches per hour	Available water capacity in./in.	Soil reaction pH	Shrink-swell potential
	Surface layer Fine sandy loam 0 to 18 inches	SM or ML	A-4	100	100	30-50	2.00-6.30	.16-.[illegible]	[illegible]	Low
	Subsoil Fine sandy loam or loam 18 to 44 inches	SC or CL	A-4 or A-6	100	100	40-65	0.[illegible]-6.30	.15-.19	[illegible]	Low
	Underlying material Loamy fine sand or fine sand 44 to 60 inches	SP or SM	A-3 or A-2	100	[illegible]-100	[illegible]-20	6.30-20.0	.05-.1[illegible]	[illegible]	[illegible]

Depth to Water Table: Greater than 6 feet
Hydrologic group: B

Depth to bedrock: Greater than 5 feet

[illegible] SOIL AS A RESOURCE MATERIAL	
Topsoil	GOOD on 0 to 7 percent slopes. FAIR on 7 to 12 percent slopes; [illegible]; low organic matter content.
Sand and gravel	FAIR to GOOD source of sand below a depth of 3 or 4 feet; usually poorly graded; [illegible]
Road fill for highway subgrade	FAIR in upper 3 or 4 feet; more than 30 percent fine material; ranges from nonplastic up to a plasticity index of 15. GOOD below a depth of 3 or 4 feet.

DEGREE OF LIMITATION [illegible]	
Highway and street location	SLIGHT on 0 to 7 percent slopes: [illegible] or moderately well drained. MODERATE on 7 to 12 percent slopes and SEVERE on 12 to 1[illegible] percent slopes: [illegible] depth of 3 to 4 [illegible] difficult to [illegible].
Foundations for low buildings	SLIGHT on 0 to 7 percent slopes: [illegible]. MODERATE on 7 to 12 percent slopes: [illegible] affect [illegible] construction. SEVERE on 12 to 1[illegible] percent slopes: slopes limit use.
Pond reservoir areas	SEVERE: Excessive seepage through sandy material.
Dams, dikes and embankments	MODERATE in subsoil: Fair to [illegible] and compaction. SEVERE in underlying material: Rapid seepage and poor resistance to piping.
Waterways	SLIGHT on 0 to 4 percent slopes, MODERATE on 4 to 12 percent slopes, and SEVERE on slopes more than 12 percent: Construction exposes infertile; highly erodible sandy material.
Drainage	SLIGHT: Natural drainage is adequate.
Terraces and diversions	SLIGHT on 0 to 7 percent slopes, MODERATE on 7 to 12 percent slopes, and SEVERE on 12 to 18 percent slopes: Construction exposes infertile, highly erodible sandy material.
Irrigation	SLIGHT on 0 to 4 percent slopes: Rapid intake rate; moderate to moderately rapid permeability; moderate available water capacity. MODERATE on 4 to 12 percent slopes and SEVERE on 12 to 1[illegible] percent slopes: Slopes are limiting; subject to wind and water erosion.
Corrosion of concrete	MODERATE: Moderate corrosion potential; strongly acid in the subsoil.

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE in cooperation with
ILLINOIS AGRICULTURAL EXPERIMENT STATION

National Cooperative Soil Survey

INTERPRETATIONS FOR CROPLAND, PASTURE, AND WOODLAND

Cropland - general and specialty farm crops	Suited to corn, [illegible] soybeans, small grain, grasses, and legumes. Requires erosion control practices on sloping areas.
Pasture	Suited to drought resistant grasses and legumes.
Woodland	Species to favor in existing stands: Black walnut, White oak, Red oak, Yellow poplar. Suitable species to plant: Black walnut, Yellow poplar, White pine, Red pine, Ash. Site index range: Upland oak - [illegible] to [illegible].

PRINCIPAL MAP UNITS, CAPABILITY, AND YIELD PREDICTIONS - yields based on a high level of management

Principal Soil Map Units	Slope Range	Erosion Condition	Capability	Soil Loss K	Soil Loss T	Corn (bu)	Soybeans (bu)	Wheat (bu)	Oats (bu)	Legume-Grass Hay (tons)	Pasture (AUD)
131A	0 to 2%	None or slight	IIs	-	-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	125
131B	3 to 4%	Slight	IIe	.28	3	[illegible]	[illegible]	[illegible]	60	3.5	[illegible]
131C	[illegible] to 7%	Slight	III	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	3.5	[illegible]
131D2	7 to 12%	Eroded	IIIe	.28	3	70	-	[illegible]	[illegible]	3.2	[illegible]
131E2	13 to 18%	Eroded	[illegible]	.28	3	[illegible]			[illegible]	[illegible]	[illegible]

SUITABILITY FOR WILDLIFE

Openland wildlife	WELL SUITED on 0 to 12 percent slopes - well suited to several species of wild herbaceous plants, hardwood woody plants, grain and seed crops, grasses, and legumes. SUITED on 12 to 18 percent slopes - moderate limitation for grasses and legumes and severe for grain and seed crops.
Woodland wildlife	WELL SUITED on 0 to 12 percent slopes - well suited to several species of hardwood woody plants and wild herbaceous plants. SUITED on 12 to 18 percent slopes - slope is moderate limitation for production of grasses and legumes; rapid growth of coniferous woody plants causes early canopy closure.
Wetland wildlife	UNSUITED: Moderately well to well drained soils; few, if any, suitable plant species for wetland food and cover; water table too deep for shallow water developments.

LIMITATIONS FOR RECREATION 1/

Cottages and utility buildings	SLIGHT on 0 to 7 percent slopes. MODERATE on 7 to 12 percent slopes - slopes limit use. SEVERE on slopes exceeding 12 percent - slopes severely limit use.
Tent and camp trailer sites	SLIGHT on 0 to 7 percent slopes. MODERATE on 7 to 12 percent slopes - slopes limit use. SEVERE on slopes exceeding 12 percent - slopes severely limit use; turf difficult to maintain.
Picnic areas	SLIGHT on 0 to 7 percent slopes. MODERATE on 7 to 12 percent slopes - slopes limit use. SEVERE on slopes exceeding 12 percent - slopes severely limit use; turf difficult to maintain.
Playgrounds	MODERATE on 0 to 7 percent slopes - slopes limit use. SEVERE on slopes exceeding 7 percent - slopes severely limit use.
Paths and trails	SLIGHT on 0 to 12 percent slopes. MODERATE on 12 to 18 percent slopes - slopes limit use. Paths and trails not on the contour are subject to erosion and [illegible] use.
Golf course fairways	SLIGHT on 0 to 7 percent slopes. MODERATE on 7 to 12 percent slopes - slopes limit use. SEVERE on slopes exceeding 12 percent - slopes severely limit use; turf difficult to maintain.

LIMITATIONS FOR SOME OTHER USES 1/

Residential, commercial and light industrial development with public sewers	SLIGHT on 0 to 7 percent slopes. Slight grading for streets and lots; subject to erosion. MODERATE on 7 to 12 percent slopes. Moderate grading for streets and lots; subject to erosion. SEVERE on slopes exceeding 12 percent; many cuts and fills for streets and lots; severe erosion and siltation during construction.
Septic tank filter fields	SLIGHT on 0 to 7 percent slopes; moderate to moderately rapid permeability in subsoil; rapid permeability below depth of 3 to 4 feet; hazard of ground water pollution. MODERATE on 7 to 12 percent slopes; slopes hinder installation. Percolation faster than 45 min./in. SEVERE on 12 to 18 percent slopes; slopes limit use.
Sewage lagoons	SEVERE: Excessive seepage through porous underlying material.

1/ The soil is evaluated to a depth of five feet. Soils are rated on the basis of three classes of soil limitations: Slight - relatively free of limitations or limitations are easily overcome; Moderate - limitations need to be recognized, but can be overcome with correct planning and careful design; Severe - limitations are severe enough to make use questionable. (Severe may be further subdivided into Severe and Very Severe where needed.) Ratings may be changed as additional experience and data are obtained. USE OF INFORMATION ON THIS SHEET DOES NOT ELIMINATE THE NEED FOR ON-SITE INVESTIGATIONS.

2 of 2

[illegible]

Map Symbol
Illinois - 279

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL SURVEY INTERPRETATIONS 1/

SERIES ROZETTA
STATE ILLINOIS
MLRA 105,108,115

The Rozetta series consists of moderately well drained soils that have 2 to 8 percent slopes and have formed in loess on uplands. They have a very dark gray or dark grayish-brown silt loam surface layer and a brown and dark yellowish-brown silty clay loam subsoil. Grayish-brown mottles are common in the subsoil. The underlying material is yellowish-brown silt loam. Rozetta soils have moderate permeability, high available water capacity, and medium to rapid runoff.

ESTIMATED SOIL PROPERTIES SIGNIFICANT TO ENGINEERING

Major Soil Horizons (Inches)	Classification			Coarse Fract. >3 in. %	Percentage less than 3 inches Passing Sieve No.--				LL	PI	Permeability in./hr.	Avail. Water Capac. in./in.	Soil Reaction pH	Shrink-Swell Potential
	USDA Texture	Unified	AASHO		4	10	40	200						
0-11	sil	ML or CL	A-4 or A-6	-	100	100	95-100	95-100	24-32	5-15	0.60-2.00	.22-.24	5.1-6.0	Low
11-50	sicl	CL	A-7 or A-6	-	100	100	95-100	95-100	40-50	19-28	0.60-2.00	.18-.20	5.1-6.0	Mod.
50-80	sil	CL or ML	A-6 or A-4	-	100	100	95-100	95-100	21-37	4-22	0.60-2.00	.20-.22	5.6-7.3	Low

Flooding: None
Hydrologic group: B
Depth to water table: 3 to 4 ft. below surface in the spring.
Depth to bedrock: Greater than 6 feet.
Corrosivity - uncoated steel: Not rated.
Corrosivity - concrete: Moderate in subsoil.

SUITABILITY OF SOIL AS SOURCE OF SELECTED MATERIAL AND FEATURES AFFECTING USE

Roadfill	Poor: Plastic index usually greater than 15.
Sand	Unsuited.
Gravel	Unsuited.
Topsoil	Fair: 9 to 18 inches of suitable material.

DEGREE AND KIND OF SOIL LIMITATION FOR SELECTED USES

Septic Tank Filter Fields	Moderate: Water table temporarily at a 36 to 48 inch depth.
Sewage Lagoons	Moderate: Depth to seasonal water table is 36 to 48 inches; moderate permeability.
Shallow Excavations	Moderate: Moderately well drained.
Dwellings: With Basements	Moderate: Plastic material; moderate shrink-swell potential.
Without Basements	Moderate: Plastic material; moderate shrink-swell potential.
Sanitary Landfill (trench)	Severe: Depth to seasonal water table 36 to 48 inches.
Local Roads and Streets	Severe: Plastic index greater than 15.
Potential Frost Action	Moderate: Underlying material periodically wet.

MAJOR SOIL FEATURES AFFECTING SELECTED USES

Pond Reservoir Areas	Moderate permeability; slight seepage hazard during dry periods.
Embankments, Dikes, and Levees	Medium to low shear strength; low permeability of compacted soil.
Drainage of Cropland and Pasture	Natural drainage usually adequate.
Irrigation	Mod. intake rate; high available water capacity; sloping areas susceptible to e[illegible]
Terraces and Diversions	Exposed subsoil acid; low in organic matter; susceptible to erosion.
Grassed Waterways	Soil susceptible to erosion during construction, subsoil strongly acid.

1/ Use in conjunction with Guide to Soil Survey Interpretation Sheets.

[illegible], 1971

Page 1 of 2
5,L-27,828

ROZETTA SERIES

DEGREE OF SOIL LIMITATION AND MAJOR FEATURES AFFECTING RECREATION USES

Camp Areas	Slight: Factors affecting use are favorable.
Picnic Areas	Slight: Factors affecting use are favorable.
Playgrounds	Slight on 0 to 2% slopes; Moderate on 2 to 7% slopes.
Paths and Trails	Slight: Factors affecting use are favorable.

CAPABILITY, SOIL LOSS FACTORS, AND POTENTIAL YIELDS--(High level management)

Phases of Series	Capability	Soil Loss K	Soil Loss T	Corn (bu)	Soybeans (bu)	Wheat (bu)	Oats (bu)	Legume-Grass Hay (tons)	Pasture (AUD)
A (0 to 2%)	I	.37	4	114	36	47	66	4.6	230
B (2 to 4%)	IIe	.37	4	112	34	44	62	4.3	225
C (4 to 7%)	IIe	.37	4	109	32	42	59	4.1	210
C2(4 to 7%)	IIe	.37	4	95	30	40	55	3.9	195

PASTURELAND AND HAYLAND

Phases of Series	Group	Species, Yield in AUMs for Dryland (Irrigated) Forage Production
	Not used	

WILDLIFE HABITAT SUITABILITY

Phases of Series	Potential for-- Grain and Seed Crops	Grasses, Legumes	Wild Herbaceous Plants	Hardwood Trees and Shrubs	Coniferous Plants	Wetland Food and Cover	Shallow Water Devel.	Potential for-- Openland Wildlife	Woodland Wildlife	Wetland Wildlife
0 to 4%	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor
4 to 7%	Fair	Good	Good	Good	Good	Poor	V.Poor	Good	Good	V.Poor

WOODLAND SUITABILITY

Phases of Series	Ordination	Potential Productivity: Important Trees	Site Index	Woodland Management Hazards: Erosion Hazard	Equipment Limitations	Seeding Mortality	Plant Competition	Suitable Species: To Favor	To Plant	Other
All	2o	W.oak R.oak Y.poplar B.walnut	85-95 Yellow poplar	Slight	Slight	Slight	Slight to Severe		W.pine B.walnut R.oak Ash W.oak	

RANGE

Phases of Series	Range Site Name	Climax Vegetation and Productivity of Air-Dry Herbage (lb./ac.)
	Not applicable.	

WINDBREAK

Group	Adapted Trees to Plant	Tree Height Prediction at 20 Years Age	Relative Vigor
No groups in Illinois.			

OTHER

EEV-DCH

Map Symbols	SEXTON	MLRA - 108 & 114	Date 11/70
Illinois - 208	Soil Series		

SOIL INTERPRETATIONS

BRIEF SOIL DESCRIPTION: The Sexton series consists of poorly drained soils that have slopes of less than 2 percent on uplands and stream terraces. They have a dark grayish-brown silt loam surface layer and a mottled grayish-brown heavy silty clay loam subsoil. The underlying material is loam or sandy loam. Sexton soils have a low organic matter content in the surface layer, slow permeability in the subsoil, and a high available water capacity. Surface water runoff is slow.

ESTIMATED PHYSICAL AND CHEMICAL PROPERTIES

General Soil Profile	Classification			% of material passing sieve			Permeability inches per hour	Available water capacity in./in.	Soil reaction pH	Shrink-swell potential
	USDA Texture	Unified	AASHO	No. 4 5.0 mm	No. 10 2.0 mm	No. 200 0.074 mm				
	Surface layer Silt loam 0 to 16 inches	CL	A-6 or A-4	100	100	90-100	0.2-0.63	.20-.25	5.6-6.5	Low
	Subsoil Heavy silty clay loam 16 to 48 inches	CL or CH	A-7	100	100	90-100	0.06-0.20	.19-.21	5.1-6.0	Moderate to high
	Underlying material Loam or sandy loam 48 to 60 inches	ML or SM	A-2 or A-4	100	95-100	30-80	2.0-6.3	.10-.14	5.6-6.5	Low

Water Table: Less than 2 feet below the surface at least 2 months during the year (usually in the spring).

SUITABILITY AND FEATURES AFFECTING SOIL AS RESOURCE MATERIAL	
Topsoil	GOOD if remaining soil at construction site is to be covered by buildings, roads, etc. POOR if remaining soil is to be reclaimed - poorly drained; seasonal high water table.
Sand and gravel	Generally not suitable.
Road fill for highway subgrade	POOR in subsoil: Fair to poor compaction, moderate to high shrink-swell potential; plastic index more than 15. FAIR in underlying material but usually saturated with water. Fair compaction; low shrink-swell.

DEGREE OF LIMITATIONS AND SOIL FEATURES AFFECTING SELECTED USES 1/		
Highway and street location	SEVERE:	Poorly drained; seasonal high water table; susceptible to frost heave; moderate to high shrink-swell potential in the subsoil.
Foundations for low buildings	SEVERE:	Poorly drained; seasonal high water table, moderate to high shrink-swell potential in the subsoil; subject to frost heave.
Pond reservoir areas	SLIGHT:	Slow permeability in the upper 4 feet, has natural high water table and potential for dugout ponds but excessive seepage is likely through permeable material below 4 feet if water table is lowered artificially.
Dams, dikes and embankments	MODERATE:	Fair stability and compaction, upper 4 feet has low permeability when compacted. Underlying material has moderate permeability when compacted and poor resistance to piping.
Waterways	Not applicable.	
Drainage	SEVERE:	Poorly drained; seasonal high water table; slow permeability; tile do not function well.
Terraces and diversions	Not applicable.	
Irrigation	SEVERE:	Slow intake rate, slow permeability, high available water capacity; surface drainage needed.
Corrosion of concrete	MODERATE:	Strongly to medium acid.

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1 OF 2
5, L-28867

INTERPRETATIONS FOR CROPLAND, PASTURE, AND WOODLAND

Cropland - general and specialty farm crops	Suited to corn, soybeans, small grain, grasses, and legumes where adequately drained, fertilized, and limed.
Pasture	Suited to a wide range of adapted grasses and legumes.
Woodland	Species to favor in existing stands: White oak, pin oak, ash Suitable species to plant: Ash, cypress, pin oak, red maple, water tupelo. Site index range: Upland oak - 65 to 75

PRINCIPAL MAP UNITS, CAPABILITY, AND YIELD PREDICTIONS - yields based on a high level of management

Principal Soil Map Units	Slope Range	Erosion Condition	Cap. Class & Subclass	Corn (bu)	Soybeans (bu)	Wheat (bu)	Oats (bu)	Legume-Grass Hay (tons)	Pasture (AUD)
208	0 to 2%	None or slight	IIIw	100	35	45	55	4.0	200

SUITABILITY FOR WILDLIFE

Openland wildlife	WELL SUITED in drained areas: well suited to several species of wild herbaceous plants, hardwood woody plants, grain and seed crops, grasses, and legumes. SUITED in undrained areas: growth of herbaceous plants, grasses, and legumes is moderately limited.
Woodland wildlife	WELL SUITED in both drained and undrained areas: suited to the establishment of several species of hardwood woody plants and herbaceous plants.
Wetland wildlife	SUITED in drained areas: number of suitable species of wetland food and cover plants is moderately limited. WELL SUITED in undrained areas: well suited to several species of wetland food and cover plants and to shallow water developments and ponds.

LIMITATIONS FOR RECREATION 1/

Cottages and utility buildings	SEVERE:	Poorly drained; subject to frost heave; moderate to high shrink-swell potential in the subsoil; seasonal high water table.
Tent and camp trailer sites	SEVERE:	Poorly drained; seasonal high water table; slow surface runoff; soil dries slowly.
Picnic areas	SEVERE:	Poorly drained; seasonal high water table; slow surface runoff; soil dries slowly.
Playgrounds	SEVERE:	Poorly drained; seasonal high water table; slow surface runoff; soil dries slowly.
Paths and trails	SEVERE:	Poorly drained; seasonal high water table; soil dries slowly.
Golf course fairways	SEVERE:	Poorly drained; seasonal high water table; slow surface runoff; soil dries slowly; turf easily damaged where wet.

LIMITATIONS FOR SOME OTHER USES 1/

Residential, commercial and light industrial development with public sewers.	SEVERE:	Frequent or continuous water saturation, slow runoff of surface water; may pond in some areas, excavations fill with water in the spring; dries out slowly, wet basements probable, foundations, slabs, walks, and streets subject to cracking and heaving caused by frost heave and shrink-swell.
Septic tank filter fields	SEVERE:	Slow permeability; seasonal high water table; subject to ponding in places; percolation rate slower than 60 minutes per inch in upper 4 feet.
Sewage lagoons	SEVERE:	Seasonal water table less than 40 inches below the surface for extended periods. Excessive seepage likely through material below 4 feet in areas where water table is lowered artificially.

1/ The soil is evaluated to a depth of five feet. Soils are rated on the basis of three classes of soil limitations: Slight - relatively free of limitations or limitations are easily overcome; Moderate - limitations need to be recognized, but can be overcome with correct planning and careful design; Severe - limitations are severe enough to make use questionable. (Severe may be further subdivided into Severe and Very Severe where needed.)

Map Symbols

Illinois - 188

BEARDSTOWN
Soil Series

MLRA 108

EEV-LJB
Date 4/71

SOIL INTERPRETATIONS

BRIEF SOIL DESCRIPTION: The Beardstown series consists of somewhat poorly drained soils that have slopes of less than 3 percent on terraces or outwash plains. They have a very dark gray loam surface layer. The subsoil is mottled grayish brown and yellowish brown clay loam. The underlying material consists of layers of loamy sand, loam, and sandy loam. Beardstown soils have a moderate organic matter content in the surface layer, moderate to moderately slow permeability in the subsoil, and a high available water capacity. Surface water runoff is slow to medium.

ESTIMATED PHYSICAL AND CHEMICAL PROPERTIES

General Soil Profile	Classification			% of material passing sieve			Permeability inches per hour	Available water capacity in./in.	Soil reaction pH	Shrink-swell potential
	USDA Texture	Unified	AASHO	No. 4 5.0 mm	No. 10 2.0 mm	No. 200 0.074 mm				
	Surface layer Loam 0 to 14 inches	ML or CL	A-4 or A-6	100	95-100	50-80	0.63-2.00	.16-.20	5.6-6.5	Low
	Subsoil Clay loam and sandy clay loam 14 to 42 inches	CL or SC	A-4 or A-6	100	95-100	40-70	0.20-2.00	.16-.18	5.1-6.0	Low to moderate
	Underlying material Stratified loamy sand, loam, and sandy loam 42 to 60 inches	SP, SM or ML	A-2, A-3 or A-4	100	85-100	15-55	0.63-6.30	.10-.14	5.1-6.0	Low

Water Table: Temporarily 1 to 3 feet below surface in the spring.
Hydrologic group: B Depth to rock: Greater than 6 feet.

SUITABILITY AND FEATURES AFFECTING SOIL AS RESOURCE MATERIAL	
Topsoil	Surface: Good - 10 to 18 inches of loam; moderate organic matter content (about 3%). Subsoil: Fair - clay loam; sticky when wet and hard when dry; low organic matter.
Sand and gravel	Generally not suitable; some sandy layers below a depth of about 4 feet.
Road fill for highway subgrade	Subsoil: Fair to poor - low to moderate shrink-swell potential; fair to good compaction characterisitcs. Underlying material: Fair to good - low shrink-swell; poor to fair compaction; plastic index usually less than 10.

DEGREE OF LIMITATIONS AND SOIL FEATURES AFFECTING SELECTED USES 1/	
Highway and street location	MODERATE: Somewhat poorly drained; seasonal high water table; susceptible to frost heave; subsoil has low to moderate shrink-swell potential and fair to good stability.
Foundations for low buildings	MODERATE: Somewhat poorly drained; seasonal high water table; susceptible to frost heave; subsoil has low to moderate shrink-swell potential.
Pond reservoir areas	SEVERE: Hazard of excessive seepage through porous underlying material in dry seasons; has high water table in the spring; potential for dugout ponds only.
Dams, dikes and embankments	SLIGHT in subsoil - fair to good stability and compaction characteristics. SEVERE in underlying material - poor to fair stability, compaction and resistance to piping.
Waterways	MODERATE: Exposed subsoil somewhat difficult to vegetate; drainage often needed to prevent soft, seepy areas.
Drainage	MODERATE: Somewhat poorly drained; seasonal high water table; moderate to moderately slow permeability in the subsoil.
Terraces and diversions	MODERATE: Generally not needed; see waterways for features affecting use.
Irrigation	MODERATE: Moderate intake rate; moderately to moderately slowly permeable subsoil; high available water capacity; drainage needed in places.
Corrosion of concrete	MODERATE: Moderate corrosion potential; strongly acid to medium acid.

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INTERPRETATIONS FOR CROPLAND, PASTURE, AND WOODLAND

Cropland - general and specialty farm crops	Well suited to commonly grown crops where adequately drained. Used mainly for growing corn and soybeans.
Pasture	Well suited to a wide range of adapted grasses and legumes.
Woodland	No natural woodlands. Suitable species to plant: Ash, White pine, Red pine, Norway spruce

PRINCIPAL MAP UNITS, CAPABILITY, AND YIELD PREDICTIONS - yields based on a high level of management

Principal Soil Map Units	Slope Range	Erosion Condition	Capability	Soil Loss K	Soil Loss T	Corn (bu)	Soybeans (bu)	Wheat (bu)	Oats (bu)	Legume-Grass Hay (tons)	Pasture (AUD)
188	0 to 3%	None to slight	IIs	.37	4	105	38	45	65	4.5	225

SUITABILITY FOR WILDLIFE

Openland wildlife	WELL SUITED:	Well suited to several species of wild herbaceous upland plants, hardwood woody plants, grain and seed crops, and grasses and legumes.
Woodland wildlife	WELL SUITED:	Well suited to the establishment of several species of wild herbaceous upland plants and hardwood woody plants. Rapid growth of coniferous woody plants causes early canopy closure.
Wetland wildlife	SUITED:	Number of suitable plant species for wetland food and cover moderately limited; inadequate water table for shallow water developments and dugout ponds during dry seasons.

LIMITATIONS FOR RECREATION 1/

Cottages and utility buildings	MODERATE:	Somewhat poorly drained; seasonal high water table; susceptible to frost heave; subsoil has low to moderate shrink-swell potential.
Tent and camp trailer sites	MODERATE:	Somewhat poorly drained; seasonal water table at 1 to 3 feet; slow to dry.
Picnic areas	MODERATE:	Somewhat poorly drained; seasonal water table at 1 to 3 feet; slow to dry.
Playgrounds	MODERATE:	Somewhat poorly drained; seasonal water table at 1 to 3 feet; slow to dry.
Paths and trails	MODERATE:	Somewhat poorly drained; seasonal water table at 1 to 3 feet; slow to dry.
Golf course fairways	MODERATE:	Somewhat poorly drained; usually soft and wet in the spring; slow to dry.

LIMITATIONS FOR SOME OTHER USES 1/

Residential, commercial and light industrial development with public sewers	MODERATE:	Periodic water saturation; excavations hold water and dry out slowly; wet basements probable; foundations, slabs, walks, and streets subject to cracking because of frost heave and shrink-swell of subsoil.
Septic tank filter fields	SEVERE:	Moderate to moderately slow permeability in the subsoil; periodically saturated with water at depths of 1 to 3 feet in the spring; coarse underlying material in some places may allow effluent to travel long distances.
Sewage lagoons	SEVERE:	Seasonal water table at less than 40 inches; hazard of excessive seepage through underlying sandy material. surface layer poor for embankment material and floor of lagoon.

1/ The soil is evaluated to a depth of five feet. Soils are rated on the basis of three classes of soil limitations: Slight - relatively free of limitations or limitations are easily overcome; Moderate - limitations need to be recognized, but can be overcome with correct planning and careful design; Severe - limitations are severe enough to make use questionable. (Severe may be further subdivided into Severe and Very Severe where needed.) Ratings may be changed as additional experience and data are obtained. USE OF INFORMATION ON THIS SHEET DOES NOT ELIMINATE THE NEED FOR ON-SITE INVESTIGATIONS.

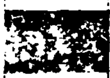
Albaqualf

Map Symbols Illinois - 16	RUSHVILLE Soil Series	MLRA 108 & 115 Date EEV-LJB 10/71

SOIL INTERPRETATIONS

BRIEF SOIL DESCRIPTION: The Rushville series consists of poorly to very poorly drained soils that have slopes of less than 2 percent on uplands. They have a dark grayish brown silt loam surface layer and a gray silty clay loam to silty clay subsoil mottled with strong brown and yellowish brown. The underlying material is silt loam. Rushville soils have a low organic matter content in the surface layer, slow to very slow permeability in the subsoil, and a high available water capacity. Surface water runoff is slow to ponded.

ESTIMATED PHYSICAL AND CHEMICAL PROPERTIES-Based on test data from Adams Co. and descriptions from Jersey and Green Counties.

General Soil Profile	Classification			% of material passing sieve			Permeability inches per hour	Available water capacity in./in.	Soil reaction pH	Shrink-swell potential
	USDA Texture	Unified	AASHO	No. 4 5.0 mm	No. 10 2.0 mm	No. 200 0.074 mm				
	Surface layer Silt loam 0 to 16 inches	CL-ML	A-4 or A-6	100	100	95-100	0.20-0.63	.20-.25	5.1-6.5	Low
	Subsoil Silty clay loam to silty clay 16 to 53 inches	CL or CH	A-7	100	100	95-100	Less than 0.06	.15-.19	4.5-6.0	Moderate to high
	Underlying material Silt loam 53 to 60 inches	CL or ML	A-6 or A-4	100	100	95-100	0.20-0.63	.18-.23	5.6-7.8	Low to moderate

Water Table: Less than 2 feet below the surface more than 2 months during the year (usually in the spring).
Hydrologic group: D Depth to rock: Greater than 6 feet.

SUITABILITY AND FEATURES AFFECTING SOIL AS RESOURCE MATERIAL

Topsoil	Good in surface if remaining soil is not to be revegetated. Poor if remaining soil is to be revegetated - poorly to very poorly drained; seasonal high water table.
Sand and gravel	Not suitable.
Road fill for highway subgrade	Poor: Moderate to high shrink-swell potential in the subsoil; plastic index more than 20.

DEGREE OF LIMITATIONS AND SOIL FEATURES AFFECTING SELECTED USES[1]

Highway and street location	SEVERE:	Poorly drained; seasonal high water table; high frost heave potential; moderate to high shrink-swell potential in the subsoil.
Foundations for low buildings	SEVERE:	Poorly drained; seasonal high water table; moderate to high shrink-swell potential in the subsoil; subject to frost heave.
Pond reservoir areas	SLIGHT:	Subsoil is slowly to very slowly permeable; underlying material is moderately slowly permeable; has natural high water table and potential for dugout ponds.
Dams, dikes and embankments	MODERATE:	Fair to poor stability and compaction; medium to high compressibility; moderate to high shrink-swell in subsoil; very slow permeability when compacted; material below 4 feet is subject to piping.
Waterways	Generally not needed. Seasonal wetness hinders construction.	
Drainage	SEVERE:	Poorly to very poorly drained; slow to very slow permeability in the subsoil; high water table; surface water ponds in places; needs surface drainage.
Terraces and diversions	Not needed.	
Irrigation	SEVERE:	Slow intake rate; slow to very slow permeability; high available water capacity; surface drainage needed.
Corrosion of concrete	MODERATE in subsoil - moderate corrosion potential; very strongly acid to medium acid. SLIGHT in underlying material - low corrosion potential; medium acid to alkaline.	

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INTERPRETATIONS FOR CROPLAND, PASTURE, AND WOODLAND

Cropland - general and specialty farm crops	Suited to continuous row cropping when adequately drained and properly managed. Used mainly for growing corn and soybeans.
Pasture	Seldom used for pasture but the soils are suited to a wide range of adapted grasses and legumes.
Woodland	Species to favor in existing stands: White oak, Pin oak, Ash. Suitable species to plant: Ash, Cypress, Pin oak, Red maple, Water tupelo. Site index range: Upland oak - 65 to 75.

PRINCIPAL MAP UNITS, CAPABILITY, AND YIELD PREDICTIONS - yields based on a high level of management

Principal Soil Map Units	Slope Range	Erosion Condition	Capability	Soil Loss K	Soil Loss T	Corn (bu)	Soybeans (bu)	Wheat (bu)	Oats (bu)	Legume-Grass Hay (tons)	Pasture (AUD)
16	0 to 2%	None	IIIw	-	-	100	35	42	60	3.8	190

SUITABILITY FOR WILDLIFE

Openland wildlife	WELL SUITED in drained areas: Well suited to several species of wild herbaceous plants, hardwood woody plants, grain and seed crops, grasses, and legumes POORLY SUITED in undrained areas: Poorly suited for growing grain and seed crops, grasses, and legumes; natural establishment of wild herbaceous plants moderately limited.
Woodland wildlife	WELL SUITED in drained areas: Suited to the establishment of several species of wild herbaceous plants and woody plants. SUITED in undrained areas: Limited production of herbaceous plants, grasses, and legumes.
Wetland wildlife	POORLY SUITED in drained areas: Number of suitable species of wetland food and cover plants severely limited. WELL SUITED in undrained areas: Well suited to several species of wetland food and cover plants and to shallow water developments.

LIMITATIONS FOR RECREATION 1/

Cottages and utility buildings	SEVERE:	Poorly to very poorly drained; subject to frost heave; moderate to high shrink-swell potential in the subsoil; seasonal high water table.
Tent and camp trailer sites	SEVERE:	Poorly to very poorly drained; seasonal high water table; slow surface runoff; soil dries slowly.
Picnic areas	SEVERE:	Poorly to very poorly drained; seasonal high water table; slow surface runoff; soil dries slowly.
Playgrounds	SEVERE:	Poorly to very poorly drained; seasonal high water table; slow surface runoff; soil dries slowly
Paths and trails	SEVERE:	Poorly to very poorly drained; seasonal high water table; slil dries slowly.
Golf course fairways	SEVERE:	Poorly to very poorly drained; seasonal high water table; slow surface runoff; soil dries slowly.

LIMITATIONS FOR SOME OTHER USES 1/

Residential, commercial and light industrial development with public sewers	SEVERE:	Frequent or continuous water saturation; slow runoff of surface water; may pond in some areas; excavations fill with water in the spring; dries out slowly; wet basements probable; foundations, slabs, walks, and streets subject to cracking and heaving caused by frost heave and shrink-swell.
Septic tank filter fields	SEVERE:	Slow to very slow permeability; seasonal high water table; subject to ponding in places; percolation rate slower than 60 minutes per inch.
Sewage lagoons	SEVERE:	Seasonal water table less than 2 feet below the surface for extended periods and water fills excavations.

1/ The soil is evaluated to a depth of five feet. Soils are rated on the basis of three classes of soil limitations: Slight - relatively free of limitations or limitations are easily overcome; Moderate - limitations need to be recognized, but can be overcome with correct planning and careful design; Severe - limitations are severe enough to make use questionable. (Severe may be further subdivided into Severe and Very Severe where needed.) Ratings may be changed as additional experience and data are obtained. USE OF INFORMATION ON THIS SHEET DOES NOT ELIMINATE THE NEED FOR ON-SITE INVESTIGATIONS

Map Symbols
Illinois - 26

WAGNER
Soil Series

MLRA 113 & 114

Date REV 10/71

SOIL INTERPRETATIONS

BRIEF SOIL DESCRIPTION : The Wagner series consists of poorly drained soils that have slopes of less than 2 percent on stream terraces. They have a very dark grayish brown silt loam surface layer and a mottled grayish brown, dark gray, and olive gray silty clay subsoil. The underlying material is silty clay loam. Wagner soils have a low to moderate organic matter content in the surface, very slow to slow permeability in the subsoil, and a moderate to high available water capacity. Surface water runoff is slow to ponded.

ESTIMATED PHYSICAL AND CHEMICAL PROPERTIES

General Soil Profile	Classification			% of material passing sieve			Permeability inches per hour	Available water capacity in./in.	Soil reaction pH	Shrink-swell potential
	USDA Texture	Unified	AASHO	No. 4 5.0 mm	No. 10 2.0 mm	No. 200 0.074 mm				
	Surface layer Silt loam 0 to 16 inches	CL or ML	A-6	100	100	95-100	0.20-0.63	.20-.25	5.1-6.0	Low
	Subsoil Silty clay 16 to 58 inches	CH	A-7	100	100	95-100	Less than .20	.11-.15	4.5-6.0	High
	Underlying material Silty clay loam 58 to 65 inches	CL	A-6 or A-7	100	100	80-95	0.06-0.20	.19-.21	6.6-7.3	Moderate to high

Water Table: Less than 2 feet below the surface at least 2 months during the year (usually in the spring).
Hydrologic group: D Depth to rock: Greater than 6 feet.

SUITABILITY AND FEATURES AFFECTING SOIL AS RESOURCE MATERIAL	
Topsoil	GOOD if remaining soil at construction site is not to be revegetated. POOR if remaining soil is to be revegetated - poorly drained; seasonal high water table.
Sand and gravel	Not suitable.
Road fill for highway subgrade	POOR: Fair to poor compaction; high shrink-swell in subsoil; plastic index more than 25.

DEGREE OF LIMITATIONS AND SOIL FEATURES AFFECTING SELECTED USES 1		
Highway and street location	SEVERE:	Poorly drained; seasonal high water table; susceptible to frost heave; high shrink-swell potential in the subsoil.
Foundations for low buildings	SEVERE:	Poorly drained; seasonal high water table; high shrink-swell potential in the subsoil; subject to frost heave.
Pond reservoir areas	SLIGHT:	Very slow to slow permeability in the subsoil; has natural high water table and potential for dugout ponds.
Dams, dikes and embankments	MODERATE:	Fair to poor stability and compaction, low permeability when compacted; high shrink-swell potential; good resistance to piping.
Waterways	Generally not needed. Seasonal wetness severely hinders construction.	
Drainage	SEVERE:	Poorly drained; seasonal high water table; slow permeability; tile do not function well.
Terraces and diversions	Terraces not needed. Seasonal wetness severely hinders construction of diversions.	
Irrigation	SEVERE:	Slow intake rate; very slow to slow permeability; moderate to high available water capacity; surface drainage needed.
Corrosion of concrete	MODERATE in subsoil: Moderate corrosion potential; very strongly acid to medium acid. SLIGHT in underlying material: Low corrosion potential; neutral.	

INTERPRETATIONS FOR CROPLAND, PASTURE, AND WOODLAND

Cropland - general and specialty farm crops	Suited to corn, soybeans, small grain, grasses, and legumes where adequately drained, fertilized, and limed.
Pasture	Suited to a wide range of adapted grasses and legumes.
Woodland	Few existing woodlands. Species to favor: Swamp white oak, Pin oak, Ash, Cottonwood, Sycamore. Suitable species to plant: Ash, Pin oak, Red maple, Cottonwood, Sycamore, Sweet gum. Site index range: Pin oak - 85 to 95.

PRINCIPAL MAP UNITS, CAPABILITY, AND YIELD PREDICTIONS - yields based on a high level of management

Principal Soil Map Units	Slope Range	Erosion Condition	Capability	Soil Loss K	Soil Loss T	Corn (bu)	Soybeans (bu)	Wheat (bu)	Oats (bu)	Legume-Grass Hay (tons)	Pasture (AUD)
26	0 to 2%	Uneroded	IIIw	-	-	90	32	42	-	3.5	190

SUITABILITY FOR WILDLIFE

Openland wildlife	**WELL SUITED** in drained areas: Well suited to several species of wild herbaceous plants, hardwood woody plants, grain and seed crops, grasses, and legumes. **SUITED** in undrained areas: Growth of herbaceous plants, grasses, and legumes is moderately limited.
Woodland wildlife	WELL SUITED in both drained and undrained areas: Well suited to the establishment of several species of hardwood woody plants and herbaceous plants in drained areas. Growth of herbaceous plants is moderately limited in undrained areas.
Wetland wildlife	SUITED in drained areas: Number of suitable species of wetland food and cover plants is moderately limited. WELL SUITED in undrained areas: Well suited to several species of wetland food and cover plants and to shallow water developments.

LIMITATIONS FOR RECREATION 1/

Cottages and utility buildings	**SEVERE:**	Poorly drained; subject to frost heave; high shrink-swell potential in the subsoil; seasonal high water table.
Tent and camp trailer sites	**SEVERE:**	Poorly drained; seasonal high water table; subject to ponding; slow surface runoff; soil dries slowly.
Picnic areas	**SEVERE:**	Poorly drained; seasonal high water table; subject to ponding; slow surface runoff; soil dries slowly.
Playgrounds	**SEVERE:**	Poorly drained; seasonal high water table; subject to ponding; slow surface runoff; soil dries slowly.
Paths and trails	**SEVERE:**	Poorly drained; seasonal high water table; soil dries slowly.
Golf course fairways	**SEVERE:**	Poorly drained; seasonal high water table; subject to ponding; slow surface runoff, soil dries slowly; turf easily damaged when wet.

LIMITATIONS FOR SOME OTHER USES 1/

Residential, commercial and light industrial development with public sewers	**SEVERE:**	Frequent or continuous water saturation; slow runoff of surface water; may pond in some areas; excavations fill with water in the spring; dries out slowly; wet basements probable; foundations, slabs, walks, and streets subject to cracking and heaving caused by frost heave and shrink-swell.
Septic tank filter fields	**SEVERE:**	Very slow to slow permeability; seasonal high water table; subject to ponding in places; percolation rate slower than 60 minutes per inch.
Sewage lagoons	**SEVERE:**	Seasonal high water table for extended periods; subject to ponding; receives runoff from higher ground.

1/ The soil is evaluated to a depth of five feet. Soils are rated on the basis of three classes of soil limitations: <u>Slight</u> - relatively free of limitations or limitations are easily overcome; <u>Moderate</u> - limitations need to be recognized, but can be overcome with correct planning and careful design; <u>Severe</u> - limitations are severe enough to make use questionable. (<u>Severe</u> may be further subdivided into <u>Severe</u> and <u>Very Severe</u> where needed.) Ratings may be changed as additional experience and data are obtained. <u>USE OF INFORMATION ON THIS SHEET DOES NOT ELIMINATE THE NEED FOR ON-SITE INVESTIGATIONS.</u>

Map Symbols
Illinois - 331

[illegible]
Soil Series

SOIL INTERPRETATIONS

BRIEF SOIL DESCRIPTION The [illegible] series consists of well drained [illegible] grayish brown silt loam surface layer. The subsoil [illegible] brown silt [illegible] with some layers of loam or sandy loam mottled with [illegible] [illegible] [illegible]

ESTIMATED PHYSICAL AND CHEMICAL PROPERTIES

General Soil Profile	Classification: USDA Texture	Unified	AASHO	% of material passing sieve: No. 4 4.7 mm	No. 10 2.0 mm	No. 200 0.074 mm	Permeability inches per hour	Available water capacity [illegible]	[illegible]	Shrink-swell potential
	Surface layer Silt loam [illegible]	[illegible]	A-4 or A-6	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Subsoil Silt loam 8 to 32 inches	ML or CL	A-4 or A-6	100	95-100	85-100	[illegible]	[illegible]	[illegible]	Low
	Underlying material Silt loam with layers of loam or sandy loam 32 to 60 inches	ML or CL	A-4 or A-6	100	95-100	85-100	[illegible]	[illegible]	[illegible]	Low

SUITABILITY AND FEATURES AFFECTING SOIL AS RESOURCE MATERIAL	
Topsoil	GOOD: Fertile; less than [illegible] percent organic matter content.
Sand and gravel	Not suitable.
Road fill for highway subgrade	FAIR TO POOR: Fair to poor stability and compaction characteristics.

DEGREE OF LIMITATIONS AND SOIL FEATURES AFFECTING SELECTED USES	
Highway and street location	SEVERE: Subject to flooding; susceptible to frost [illegible]
Foundations for low buildings	SEVERE: Subject to flooding; susceptible to frost heave [illegible]
Pond reservoir areas	SEVERE: Subject to flooding; underlain by sandy material in places; hazard of excessive seepage.
Dams, dikes and embankments	MODERATE: Fair to poor stability and compaction; moderate permeability when compacted; medium compressibility; fair resistance to piping.
Waterways	Not applicable.
Drainage	SLIGHT: Natural drainage is adequate but subject to flooding unless protected by levees.
Terraces and diversions	Terraces not needed; diversions may be needed in some places to intercept runoff [illegible]
Irrigation	MODERATE: Moderate intake rate; moderate permeability; high available water [illegible] flooding unless protected by levees.
Corrosion of concrete	SLIGHT: Low corrosion potential; medium acid to neutral.

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SOIL CONSERVATION SERVICE in cooperation with
ILLINOIS AGRICULTURAL EXPERIMENT STATION

National Cooperative Soil Survey [illegible]

INTERPRETATIONS FOR CROPLAND, PASTURE, AND WOODLAND

Cropland - general and specialty farm crops	Well suited to continuous row crops where high level of management is used. Corn and soybeans are the main crops grown.
Pasture	Seldom used for pasture but well suited to a wide range of adapted grasses and legumes.
Woodland	Species in stands [illegible] exist: [illegible] cottonwood, [illegible] black walnut [illegible]. Suitable species to plant: [illegible] black walnut, tulip poplar. [illegible]

PRINCIPAL MAP UNITS, CAPABILITY, AND YIELD PREDICTIONS - yields based on a high level of management

Principal Soil Map Units	Slope Range	Erosion Condition	Cap. Class & Subclass	Corn (bu)	Soybeans (bu)	Wheat (bu)	Oats (bu)	Legume-Grass Hay (tons)	Pasture (AUD)
[illegible]	[illegible] 2%	[illegible]	I	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

SUITABILITY FOR WILDLIFE

Openland wildlife	WELL SUITED: well suited to several species of wild herbaceous plants, hardwood woody plants, grasses and legumes; grain and seed crops may be damaged by flooding.
Woodland wildlife	WELL SUITED: well suited to the establishment of several species of hardwood woody plants, wild herbaceous plants, grasses and legumes. Rapid growth of coniferous woody plants causes early canopy closure.
Wetland wildlife	UNSUITED: well drained; number of suitable plants for wetland food and cover very severely limited; inadequate water table for shallow water developments and ponds.

LIMITATIONS FOR RECREATION 1/

Cottages and utility buildings	SEVERE: On flood plain; subject to flooding; subject to frost heave; poor stability when wet.
Tent and camp trailer sites	SEVERE: On flood plain; subject to flooding. Frequency varies.
Picnic areas	MODERATE: On flood plain; subject to flooding. Frequency varies.
Playgrounds	SEVERE: On flood plain; subject to flooding. Frequency varies.
Paths and trails	MODERATE: On flood plain; subject to flooding. Frequency varies.
Golf course fairways	MODERATE: On flood plain; subject to flooding. Frequency varies.

LIMITATIONS FOR SOME OTHER USES 1/

Residential, commercial and light industrial development with public sewers	SEVERE: Subject to flooding; fair to poor stability; foundations, slabs, walks, and streets subject to cracking because of frost heave.
Septic tank filter fields	SEVERE: Subject to flooding; water table at less than [illegible] inches in the spring in some areas.
Sewage lagoons	SEVERE: Subject to flooding; moderate permeability; excavation may expose sandy layers in some areas.

1/ **The soil is evaluated to a depth of five feet. Soils are rated on the basis of three classes of soil limitations: Slight - relatively free of limitations or limitations are easily overcome; Moderate - limitations need to be recognized, but can be overcome with correct planning and careful design; Severe - limitations are severe enough to make use questionable. (Severe may be further subdivided into Severe and Very Severe where needed.)**

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOILS-5 (Rev. 1)
Attachment-1

SOIL SURVEY INTERPRETATIONS

MLRA(S): 10X, 114, 115 | KIND OF UNIT: SERIES | UNIT NAME: DUPO

STATE: ILLINOIS | RECORD NO: [illegible] | AUTHOR(S): [illegible] | DATE: [illegible]-73 | REVISED: | UNIT MODIFIER:

CLASSIFICATION AND BRIEF SOIL DESCRIPTION

THE DUPO SERIES CONSISTS OF SOMEWHAT POORLY DRAINED SOILS FORMED IN RECENT AND THE UNDERLYING OLDER ALLUVIUM ON BOTTOMLANDS. THEY HAVE 0 TO 2 PERCENT SLOPES. TYPICALLY, THE [illegible] LAYER IS DARK BROWN SILT LOAM ABOUT 7 INCHES THICK. THE UNDERLYING MATERIAL IS [illegible] SILT LOAM ABOUT [illegible] INCHES THICK WHICH IS UNDERLAIN BY A VERY DARK GRAY SILT[illegible] [illegible] THEY ARE [illegible] SUITED.

DEPTH (IN)	USDA TEXTURE	UNIFIED	AASHTO	FRACT >3 IN (PCT)	PERCENT OF MATERIAL LESS THAN 3" PASSING SIEVE NO. 4	10	40	200	LIQUID LIMIT	PLAS-TICITY INDEX
[illegible]	SIL	ML, CL	A-4, A-6	0	100	100	[illegible]	95-100	[illegible]-31	[illegible]-14
[illegible]	SIL	ML, CL	A-4, A-6	0	100	100	[illegible]	95-100	[illegible]-35	[illegible]-17
[illegible]	SICL, C, SICL	CL	A-7, A-6	0	100	100	[illegible]	98-100	36-50	18-28

DEPTH (IN)	PERMEABILITY (IN/HR)	AVAILABLE WATER CAPACITY (IN/IN)	SOIL REACTION (PH)	SALINITY (MMHOS/CM)	SHRINK-SWELL POTENTIAL	CORROSIVITY STEEL	CONCRETE	EROSION FACTORS K	T
[illegible]	[illegible]-2.0	.22-.24	5.6-7.3	—	LOW	HIGH	MOD	[illegible]	5
[illegible]	[illegible]	.2[illegible]	5.6-8.4	—	LOW	HIGH	[illegible]	[illegible]	
[illegible]	[illegible]	.03-.19	[illegible]-7.8	—	HIGH	HIGH	LOW		

FLOODING FREQUENCY	DURATION	MONTHS	HIGH WATER TABLE DEPTH (FT)	KIND	MONTHS	CEMENTED PAN DEPTH	HARDNESS	BEDROCK DEPTH (IN)	HARDNESS	SUBSIDENCE INITIAL	TOTAL	HYD GRP	POTENTIAL FROST ACTION
FREQ	LONG	MAR-JUN	1-3	APPAR	MAR-JUN	—		>60				C	HIGH

SANITARY FACILITIES		SOURCE MATERIAL	
SEPTIC TANK ABSORPTION FIELDS	SEVERE - PERCS SLOWLY, WET, FLOODS	ROADFILL	POOR - FROST ACTION
SEWAGE LAGOONS	SEVERE - WET, FLOODS	SAND	UNSUITED
SANITARY LANDFILL (TRENCH)	SEVERE - WET, FLOODS, TOO CLAYEY	GRAVEL	UNSUITED
SANITARY LANDFILL (AREA)	SEVERE - WET, FLOODS	TOPSOIL	FAIR - THIN LAYER
DAILY COVER FOR LANDFILL	FAIR - THIN LAYER		

COMMUNITY DEVELOPMENT		WATER MANAGEMENT	
		POND RESERVOIR AREA	FAVORABLE
SHALLOW EXCAVATIONS	SEVERE - WET, FLOODS	EMBANKMENTS DIKES AND LEVEES	SHRINK-SWELL
DWELLINGS WITHOUT BASEMENTS	SEVERE - FLOODS, SHRINK-SWELL	AQUIFER FED EXCAVATED PONDS	FAVORABLE
DWELLINGS WITH BASEMENTS	SEVERE - FLOODS, WET	DRAINAGE	PERCS SLOWLY, FLOODS
SMALL COMMERCIAL BUILDINGS	SEVERE - FLOODS, SHRINK-SWELL	IRRIGATION	WET, SLOW INTAKE
LOCAL ROADS AND STREETS	SEVERE - FLOODS, FROST ACTION	TERRACES AND DIVERSIONS	NOT NEEDED
		GRASSED WATERWAYS	NOT NEEDED

FOOTNOTES

REGIONAL INTERPRETATIONS

UNIT NAME DUPO
UNIT MODIFIER

	FOOTNOTE			FOOTNOTE
CAMP AREAS	SEVERE - FLOODS, WET		PLAYGROUNDS	MODERATE - FLOODS, WET
PICNIC AREAS	MODERATE - WET, FLOODS		PATHS AND TRAILS	MODERATE - WET

CAPABILITY AND PREDICTED YIELDS (CROPS AND PASTURE) (HIGH LEVEL MANAGEMENT)

CLASS DETERMINING PHASE	CAPABILITY NIRR	CAPABILITY IRR	CORN (BU) NIRR	CORN (BU) IRR	SOYBEANS (BU) NIRR	SOYBEANS (BU) IRR	WHEAT (BU) NIRR	WHEAT (BU) IRR	OATS (BU) NIRR	OATS (BU) IRR	GRASS-LEGUME HAY (TONS) NIRR	GRASS-LEGUME HAY (TONS) IRR	ALSIKY-FESCUE (AUM) NIRR	ALSIKY-FESCUE (AUM) IRR	NIRR	IRR
0-2%	2W		[illegible]		37		45		27		4.5		7.0			

WOODLAND SUITABILITY

CLASS DETERMINING PHASE	ORD SYM	EROSION HAZARD	EQUIP. LIMIT	SEEDLING MORTALITY	WINDTHROW HAZARD	PLANT COMPETITION	IMPORTANT TREES	SITE INDEX	TREES TO PLANT
							NONE		BLACK WALNUT SYCAMORE E. COTTONWOOD GREEN ASH YELLOW POPLAR RED MAPLE CHERRY BARK OAK

WIND BREAKS

CLASS DETERMINING PHASE	SPECIES	HT	SPECIES	HT	SPECIES	HT	SPECIES	HT
0-2%	NORWAY SPRUCE AUTUMN OLIVE		WHITE PINE GRAY DOGWOOD		DOUGLAS FIR SILKY DOGWOOD		AMUR MAPLE	

WILDLIFE HABITAT SUITABILITY

CLASS DETERMINING PHASE	GRAIN & SEED	GRASS & LEGUME	WILD HERB.	HARDWD TREES	CONIFER PLANTS	SHRUBS	WETLAND PLANTS	SHALLOW WATER	OPENLAND WILDLIFE	WOODLAND WILDLIFE	WETLAND WILDLIFE	RANGELAND WILDLIFE
0-2%	FAIR	GOOD	GOOD	GOOD	GOOD	-	FAIR	GOOD	GOOD	GOOD	FAIR	-

(POTENTIAL FOR HABITAT ELEMENTS: Grain & Seed through Shallow Water; POTENTIAL AS HABITAT FOR: Openland through Rangeland Wildlife)

POTENTIAL NATIVE PLANT COMMUNITY (RANGELAND OR FOREST UNDERSTORY VEGETATION)

COMMON PLANT NAME	PLANT SYMBOL (NLSPN)	PERCENTAGE COMPOSITION (DRY WEIGHT) BY CLASS DETERMINING PHASE

POTENTIAL PRODUCTION (LBS./AC. DRY WT.):
FAVORABLE YEARS
NORMAL YEARS
UNFAVORABLE YEARS

FOOTNOTES

A1 HIGH CLAY CONTENT IN LOWER LAYERS

Fluvaquent

Map Symbols
Illinois - 334

BIRDS
Soil Series

[illegible]

SOIL INTERPRETATIONS

BRIEF SOIL DESCRIPTION: The Birds series consists of [illegible] drained [illegible] grayish-brown silt loam surface layer. Below the surface [illegible] low organic matter content [illegible] moderately slow [illegible] to slowly [illegible]

ESTIMATED PHYSICAL AND CHEMICAL PROPERTIES - Based on test data from Clark County, Illinois

General Soil Profile	Classification: USDA Texture	Classification: Unified	Classification: AASHO	% of material passing sieve: No. 4 (5.0 mm)	% of material passing sieve: No. 10 (2.0 mm)	% of material passing sieve: No. 200 (0.074 mm)	Permeability inches per hour	Available water capacity in./in.	Soil reaction pH	Shrink-swell potential
	Surface layer Silt loam 0 to 4 inches	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Subsoil Silt loam 4 to 24 inches	ML or CL	A-4 or A-6	100	100	90-100	0.2-0.63	.18-.22	[illegible]	Low
	Underlying material Silt loam 24 to 60 inches	ML or CL	A-4 or A-6	[illegible]	100	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Water Table: At 0 to 3 feet at least 2 months of the year usually in the spring.

SUITABILITY AND FEATURES AFFECTING SOIL AS A SOURCE OF [illegible]		
Topsoil	POOR:	Poorly drained; low in organic matter and fertility; [illegible] water table [illegible] remaining soil.
Sand and gravel	Not suitable.	
Road fill for highway subgrade	POOR:	Poorly drained, saturated with water [illegible] frost heave [illegible] compaction characteristics.

DEGREE OF LIMITATIONS AND SOIL FEATURES AFFECTING SELECTED USES		
Highway and street location	SEVERE:	Bottomland soil, subject to flooding [illegible] poor stability when wet.
Foundations for low buildings	SEVERE:	Subject to flooding, high water table [illegible] fair to poor shear strength, may liquefy.
Pond reservoir areas	MODERATE:	Subject to flooding, nearly level, has seasonal high water table [illegible] ponds.
Dams, dikes and embankments	SEVERE:	Poor to fair stability and compaction, low to moderate permeability when [illegible] to high compressibility, poor resistance to piping [illegible]
Waterways	Not applicable.	
Drainage	SEVERE:	Drainage and flood protection needed; moderately slow to slow permeability [illegible] seasonal high water table.
Terraces and diversions	Not applicable.	
Irrigation	SEVERE:	High available water capacity, slow intake rate [illegible] poorly drained; subject to flooding.
Corrosion of concrete	SLIGHT:	Low corrosion potential.

REV. 4-70

INTERPRETATIONS FOR CROPLAND, PASTURE, AND WOODLAND

Cropland - general and specialty farm crops	Suited to continuous row crops where adequately drained and properly fertilized. Used [illegible] growing corn and soybeans. Flooding usually damages small grains.
Pasture	Seldom used [illegible] undrained areas. [illegible] to water tolerant grasses [illegible]
Woodland	[illegible] pin oak, cottonwood, sweetgum, ash, cherrybark [illegible] Suitable [illegible] cottonwood, sycamore, sweetgum [illegible] cottonwood [illegible] to 105.

PRINCIPAL MAP UNITS, CAPABILITY AND YIELD PREDICTIONS - **yields based on a high level of management**

Principal Soil Map Units	Slope Range	Erosion Condition	Cap. Class & Subclass	Corn (bu)	Soybeans (bu)	Wheat (bu)	Oats (bu)	Legume-Grass Hay (tons)	Pasture (AUD)
334	[illegible] to 2	[illegible]	[illegible]w	[illegible]	35	[illegible]	[illegible]	[illegible] tons	200

SUITABILITY FOR WILDLIFE

Openland wildlife	WELL SUITED on drained and protected areas. SUITED on undrained areas: [illegible] of grain and seed crops, wild herbaceous plants, grasses, and legumes [illegible] by wetness and flooding.
Woodland wildlife	[illegible] the establishment of several species of hardwood woody plants. [illegible] plants moderately limited.
Wetland wildlife	[illegible] drained and protected areas: number of suitable species of wetland food and [illegible] plants [illegible] limited. SUITED on undrained areas: suited to several species of wetland food and cover plants, shallow water developments and ponds.

LIMITATIONS FOR RECREATION 1/

Cottages and utility buildings	SEVERE: Poorly drained; subject to flooding; seasonal high water table; subject to frost heave.
Tent and camp trailer sites	SEVERE: Poorly drained; subject to flooding; seasonal high water table; dries slowly.
Picnic areas	SEVERE: Poorly drained; subject to flooding; seasonal high water table; dries slowly.
Playgrounds	SEVERE: Poorly drained; subject to flooding; seasonal high water table; dries slowly.
Paths and trails	SEVERE: Poorly drained; subject to flooding; seasonal high water table; dries slowly.
Golf course fairways	SEVERE: Poorly drained; subject to flooding; seasonal high water table; dries slowly.

LIMITATIONS FOR SOME OTHER USES 1/

Residential, commercial and light industrial development with public sewers	SEVERE: Subject to flooding; frequent or continuous water saturation; excavations fill with water; slow to dry; fair to poor stability; foundations, slabs, walks, and streets subject to [illegible] because of frost heave.
Septic tank filter fields	SEVERE: Poorly drained; [illegible] to flooding; seasonal high water table; [illegible] slowly permeable; [illegible] slower than [illegible] minutes per [illegible].
Sewage lagoons	SEVERE: [illegible] seasonal high water table [illegible]

1/ The soil is evaluated to a depth of five feet. Soils are rated on the basis of three classes of soil limitations: Slight - relatively free of limitations or limitations are easily overcome; Moderate - limitations need to be recognized, but can be overcome with correct planning and careful design; Severe - limitations are severe enough to make use questionable. (Severe may be further subdivided into Severe and Very Severe where needed.)

[illegible] OF [illegible]
5, L-28867

Map Symbols
Illinois - 333

WAKELAND
Soil Series

SOIL INTERPRETATIONS

MLRA 10[illegible],113,11[illegible],115,1[illegible] Date [illegible]/77

BRIEF SOIL DESCRIPTION: The Wakeland series consists of somewhat poorly drained soils that have slopes [illegible] per cent on bottomlands. They have a grayish-brown or brown silt loam surface layer. Below the surface layer to a depth of about 30 inches is grayish-brown silt loam mottled with yellowish brown. The underlying material is commonly [illegible] silt loam mottled with grayish brown but may include loam and sandy loam layers. [illegible] soils [illegible] content [illegible] moderate permeability and [illegible] available [illegible] capacity.

ESTIMATED PHYSICAL AND CHEMICAL PROPERTIES [illegible]

General Soil Profile	USDA Texture	Classification Unified	Classification AASHO	% of material passing sieve No. 4	No. 10	No. 200	Permeability inches per hour	Available water capacity	Reaction pH	Shrink-swell potential
	Surface layer Silt loam 0 to 8 inches	ML	A-4	100	100	[illegible]	0.[illegible]-2.00	[illegible]	[illegible]-7.3	Low
	Subsoil Silt loam 8 to 30 inches	ML	A-4	100	100	[illegible]	[illegible]	[illegible]	[illegible]-7.3	Low
	Underlying material Silt loam, loam, and sandy loam [illegible]	ML or SM	A-4 or A-2	100	90-100	30-90	0.[illegible]-6.30	.17-.[illegible]	[illegible]-7.3	Low

Depth to Water Table: Seasonally at 0 to 3 feet (usually in the spring).
Hydrologic group: B Depth to Bedrock: Greater than 5 feet.

[illegible]

Topsoil	GOOD but subject to flooding; seasonal high water table.
Sand and gravel	Not suitable.
Road fill for highway subgrade	FAIR TO POOR: Poor stability and compaction characteristics; seasonal high water table; subject to flooding; susceptible to frost action.

[illegible]

Highway and street location	SEVERE:	Bottomland subject to flooding; seasonal high water table; subject to [illegible]; poor stability when wet.
Foundations for low buildings	SEVERE:	Subject to flooding; seasonal high water table; medium to high compressibility; low shrink-swell; fair to poor shear strength; may liquefy.
Pond reservoir areas	MODERATE:	Subject to flooding; nearly level; seasonal high water table and potential [illegible] ponds in undrained areas; hazard of seepage in drained areas.
Dams, dikes and embankments	SEVERE:	Poor stability and compaction; moderate permeability when compacted; [illegible] compressibility; poor resistance to piping [illegible]
Waterways		Generally not needed; seasonal wetness may interfere with construction.
Drainage	MODERATE:	Seasonal high water table; moderate permeability; drainage needed; [illegible] medium acid to neutral; subject to flooding.
Terraces and diversions		Terraces not needed. In places, diversions [illegible] runoff from higher ground; seasonal wetness may [illegible]
Irrigation	MODERATE:	Moderate intake rate; [illegible] permeability [illegible] drainage and flood protection.
Corrosion of concrete	SLIGHT:	Low corrosion potential; [illegible] acid to neutral.

UNITED STATES DEPARTMENT OF AGRICULTURE [illegible]
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INTERPRETATIONS FOR CROPLAND, PASTURE, AND WOODLAND

Cropland - general and specialty farm crops	Well suited to continuous row crops where adequately drained and properly fertilized. Used mainly for growing corn and soybeans.
Pasture	Seldom used for pasture except in undrained areas. Suited to a wide range of adapted grasses and legumes.
Woodland	Species to favor in existing stands: Cotton[illegible] poplar [illegible] maple [illegible] Pin [illegible] Suitable species to plant: Cottonwood, sycamore, pin oak, [illegible] sweetgum Site Index Range: Pin oak = [illegible]

PRINCIPAL MAP UNITS, CAPABILITY, AND YIELD PREDICTIONS - yields based on a high level of management

Principal Soil Map Units	Slope Range	Erosion Condition	Cap. Class & Subclass	Corn (bu)	Soybeans (bu)	Wheat (bu)	Oats (bu)	Legume-Grass Hay (tons)	Pasture (AUD)
333	0 to 2%	Uneroded	II[illegible]	[illegible]	40	[illegible]	-	[illegible]	250

SUITABILITY FOR WILDLIFE

Openland wildlife	WELL SUITED: Well suited to several species of wild herbaceous plants, hardwood woody plants, grasses, and legumes; suited to grain and seed crops.
Woodland wildlife	WELL SUITED in drained areas: Well suited to several species of hardwood woody plants, wild herbaceous plants, grasses, and legumes. SUITED in undrained areas: Growth of grasses and legumes moderately limited.
Wetland wildlife	SUITED: Number of suitable plant species for wetland food and cover moderately limited; inadequate water table for shallow water developments during dry seasons.

LIMITATIONS FOR RECREATION 1/

Cottages and utility buildings	SEVERE: Somewhat poorly drained; subject to flooding; seasonal high water table; subject to frost heave.
Tent and camp trailer sites	SEVERE: Somewhat poorly drained; subject to flooding; seasonal high water table; dries slowly.
Picnic areas	MODERATE TO SEVERE: Subject to flooding; seasonal high water table; dries slowly.
Playgrounds	SEVERE: Somewhat poorly drained; subject to flooding; seasonal high water table; dries slowly.
Paths and trails	MODERATE: Somewhat poorly drained; subject to flooding; seasonal high water table.
Golf course fairways	SEVERE: Somewhat poorly drained; subject to flooding; seasonal high water table; dries slowly; turf easily damaged when wet.

LIMITATIONS FOR SOME OTHER USES 1/

Residential, commercial and light industrial development with public sewers	SEVERE: Subject to flooding; periodic water saturation. Excavations fill with water in the spring; fair to poor stability; foundations, slabs, walls, and streets subject to cracking because [illegible]
Septic tank filter fields	SEVERE: Subject to flooding; seasonal high water table; moderate permeability; estimated percolation rate faster than [illegible] minutes per inch.
Sewage lagoons	SEVERE: Subject to flooding; seasonal high water table.

1/ The soil is evaluated to a depth of five feet. Soils are rated on the basis of three classes of soil limitations: Slight - relatively free of limitations or limitations are easily overcome; Moderate - limitations need to be recognized, but can be overcome with correct planning and careful design; Severe - limitations are severe enough to make use questionable. (Severe may be further subdivided into Severe and Very Severe where needed. Ratings may be changed as additional experience and data are obtained. USE OF INFORMATION ON THIS SHEET DOES NOT ELIMINATE THE NEED FOR ON-SITE INVESTIGATIONS.

Map Symbols

Illinois - 77

HUNTSVILLE
Soil Series

MLRA 95,105,108,114,115 Date EEV-GWH 12/71

SOIL INTERPRETATIONS

BRIEF SOIL DESCRIPTION: The Huntsville series consists of moderately well drained and well drained nearly level soils on bottomlands. They have a black to very dark grayish-brown silt loam surface layer. The underlying material is dark brown with some layers of loam or sandy loam mottled with yellowish brown, gray, and dark brown. Huntsville soils have a high organic matter content in the surface layer, moderate permeability, and a high available water capacity. Surface runoff is slow.

ESTIMATED PHYSICAL AND CHEMICAL PROPERTIES

General Soil Profile	Classification			% of material passing sieve			Permeability inches per hour	Available water capacity in./in.	Soil reaction pH	Shrink-swell potential
	USDA Texture	Unified	AASHO	No. 4 5.0 mm	No. 10 2.0 mm	No. 200 0.074 mm				
	Surface layer Silt loam 0 to 36 inches	CL or ML	A-6 or A-4	100	95-100	85-100	0.63-2.00	.22-.24	6.1-7.3	Low
	Underlying material Silt loam or loam 36 to 60 inches	CL or ML	A-6 or A-4	100	85-95	58-95	0.63-2.00	.18-.20	6.1-7.8	Low

Depth to Water Table: Greater than 5 feet.
Hydrologic group: B

Flooding: Subject to annual flooding unless protected.
Depth to Bedrock: Greater than 6 feet.

SUITABILITY AND FEATURES AFFECTING SOIL AS RESOURCE MATERIAL	
Topsoil	**GOOD:** Silt loam surface layer more than 2 feet thick; high organic matter content.
Sand and gravel	**Not suitable.**
Road fill for highway subgrade	**FAIR TO POOR: Fair to poor stability and compaction** characteristics; subject to flooding.

DEGREE OF LIMITATIONS AND SOIL FEATURES AFFECTING SOIL USED FOR	
Highway and street location	SEVERE: Subject to flooding; susceptible to frost heave; poor stability when wet.
Foundations for low buildings	SEVERE: Subject to flooding; susceptible to frost heave; poor stability when wet.
Pond reservoir areas	SEVERE: Subject to flooding; underlain by sandy material in places; hazard of excessive seepage.
Dams, dikes and embankments	**MODERATE:** Fair to poor stability and compaction; moderate permeability when compacted; medium compressibility; fair resistance to piping.
Waterways	**Seldom used;** no major construction problems; subject to flooding.
Drainage	**SLIGHT:** Natural drainage is adequate but subject to flooding unless protected by levees.
Terraces and diversions	**Terraces** not needed. **Diversions** may be needed in some places to intercept runoff from higher ground.
Irrigation	**MODERATE: Moderate intake rate;** moderate permeability; high available water capacity; subject to flooding unless protected by levees.
Corrosion of concrete	**SLIGHT:** Low corrosion potential; slightly acid to mildly alkaline.

UNITED STATES DEPARTMENT OF AGRICULTURE
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National Cooperative Soil Survey

INTERPRETATIONS FOR CROPLAND, PASTURE, AND WOODLAND

Cropland - general and specialty farm crops	Well suited to continuous row crops where high level of management is used. Corn and soybeans are the main crops grown.
Pasture	Seldom used for pasture but well suited to a wide range of adapted grasses and legumes.
Woodland	Few existing woodlands. Suitable species to plant: Sugar maple, Cottonwood, Black walnut, Yellow poplar, White pine, Red pine. Site index range (estimated): Yellow poplar - [illegible]; Cotton[illegible]

PRINCIPAL MAP UNITS, CAPABILITY, AND YIELD PREDICTIONS - yields based on a high level of management

Principal Soil Map Units	Slope Range	Erosion Condition	Cap. Class & Subclass	Corn (bu)	Soybeans (bu)	Wheat (bu)	Oats (bu)	Legume-Grass Hay (tons)	Pasture (AUD)
77	0 to 2%	*Uneroded*	I	130	45	[illegible]	40	[illegible]	275

SUITABILITY FOR WILDLIFE

Openland wildlife	WELL SUITED: Well suited to several species of wild herbaceous plants, hardwood woody plants, grasses, and legumes; grain and seed crops may be damaged by flooding.
Woodland wildlife	WELL SUITED: Well suited to the establishment of several species of hardwood woody plants, wild herbaceous plants, grasses, and legumes. Rapid growth of coniferous woody plants causes early canopy closure.
Wetland wildlife	UNSUITED: Well drained; number of suitable plants for wetland food and cover very severely limited; inadequate water table for shallow water developments.

LIMITATIONS FOR RECREATION 1/

Cottages and utility buildings	SEVERE:	On flood plain; subject to flooding; subject to frost heave; poor stability when wet.
Tent and camp trailer sites	SEVERE:	On flood plain; subject to flooding. Frequency varies.
Picnic areas	MODERATE:	On flood plain; subject to flooding. Frequency varies.
Playgrounds	SEVERE:	On flood plain; subject to flooding. Frequency varies.
Paths and trails	MODERATE:	On flood plain; subject to flooding. Frequency varies.
Golf course fairways	MODERATE:	On flood plain; subject to flooding. Frequency varies.

LIMITATIONS FOR SOME OTHER USES 1/

Residential, commercial and light industrial development with public sewers	SEVERE:	Subject to flooding; fair to poor stability; foundations, slabs, walks, and streets subject to cracking because of frost heave.
Septic tank filter fields	SEVERE:	Subject to flooding; soil is moderately permeable and estimated percolation rate is faster than 45 minutes per inch.
Sewage lagoons	SEVERE:	Subject to flooding; moderate permeability; upper 2 to 3 feet high in organic matter.

1/ The soil is evaluated to a depth of five feet. Soils are rated on the basis of three classes of soil limitations. Slight - relatively free of limitations or limitations are easily overcome; Moderate - limitations need to be recognized, but can be overcome with correct planning and careful design; Severe - limitations are severe enough to make use questionable. (Severe may be further subdivided into Severe and Very Severe where needed.) Ratings may be changed as additional experience and data are obtained. USE OF INFORMATION ON THIS SHEET DOES NOT ELIMINATE THE NEED FOR ON-SITE INVESTIGATIONS.

Hapludolls

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOIL SURVEY INTERPRETATIONS [1]

SERIES FATIMA
STATE MISSOURI
MLRA 109
5-30-72

The Fatima series consists of deep moderately well drained, moderately permeable soils. Typically, the surface is very dark grayish brown silt loam and the subsoil is dark, grayish brown silt loam. Fatima soils occupy flood plain positions adjacent to major streams and along old meanders where channel straightening has occured. Slope gradients are less than 2 percent.

ESTIMATED SOIL PROPERTIES SIGNIFICANT TO ENGINEERING

Major Soil Horizons (inches)	Classification			Coarse Fract. >3 in. %	Percentage less than 3 inches Passing Sieve No.				LL	PI	Permeability in./hr.	Avail. Water Capacity in./in.	Soil Reaction pH	Shrink-Swell Potential
	USDA Texture	Unified	AASHO		4	10	40	200						
0 - 64	sil	[illegible]1	A-6	-	-	100	95-100	90-100	30-40	14-18	0.6-2.0	.20-[illegible]	[illegible].1-[illegible].3	Low

Flooding: Occasional (2-5 day duration)

Hydrologic group: C

Depth to water table: Flucuates with rise and fall of adjacent streams

Depth to bedrock: More than 60 inches

Corrosivity - uncoated steel: Low

Corrosivity - concrete: Low

SUITABILITY OF SOIL AS SOURCE OF SELECTED MATERIAL AND FEATURES AFFECTING USE

Roadfill	Fair- Engineering Soil Class
Sand	Unsuited
Gravel	Unsuited
Topsoil	Good

DEGREE AND KIND OF SOIL LIMITATION FOR SELECTED USES

Septic Tank Filter Fields	Severe- flooding
Sewage Lagoons	Severe- flooding
Shallow Excavations	Severe- flooding
Dwellings: With Basements	Severe- flooding
Dwellings: Without Basements	Severe- flooding
Sanitary Landfill	Severe- flooding
Local Roads and Streets	Moderate- flooding, Engineering soil class
Potential Frost Action	

MAJOR SOIL FEATURES AFFECTING SELECTED USES

Pond Reservoir Areas	Moderately permeable, flucuating water table
Embankments, Dikes, and Levees	Moderate- compacted stability
Drainage of Cropland and Pasture	floods, flucuation, water table, moderately permeable
Irrigation	High available water capacity
Terraces and Diversions	Level bottomland
Grassed Waterways	Level bottomland

1 Use in conjunction with Guide to Soil Survey Interpretation Sheets

Fatima--2

DEGREE OF SOIL LIMITATION AND MAJOR FEATURES AFFECTING RECREATION USES

Camp Areas	Severe: flooding	Cabin Sites	Severe: flooding
Picnic Areas	Moderate: flooding	Golf Fairways	Moderate: flooding
Playgrounds	Moderate: flooding		
Paths and Trails	None- slight		

CAPABILITY, SOIL LOSS FACTORS, AND POTENTIAL YIELDS--High Level Management

Phases of Series	Capability	Soil Loss K	Soil Loss T	Corn (BU)	Soybeans (BU)	Wheat (BU)	Alfalfa-[illegible] (LBS)	Brome-K.B. Stubble (AUM)
Protected from flooding	I	-	-	125	[illegible]	[illegible]0	6,000	[illegible]

PASTURELAND AND HAYLAND

Phases of Series	Group	Species, Yields in AUMs for Dryland (Irrigated) Forage Production

WILDLIFE HABITAT SUITABILITY

Phases of Series	Potential for: Grain and Seed Crops	Grasses, Legumes	Wild Herbaceous Plants	Hardwood Trees and Shrubs	Coniferous Plants	Wetland Food and Cover	Shallow Water Devel.	Potential for: Openland Wildlife	Woodland Wildlife	Wetland Wildlife
All	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor

WOODLAND SUITABILITY

Phases of Series	Ordination	Potential Productivity: Important Trees	Site Index	Woodland Management Hazards: Erosion Hazard	Equipment Limitations	Seeding Mortality	Plant Competition	Suitable Species: To Favor	To Plant	Other
sil	2o2	Pin Oak Pecan	85 55	Slight	Slight	Slight	Moderate	Pin Oak Pecan	Pin Oak Pecan Cotton-wood	

RANGE

Phases of Series	Range Site Name	Climax Vegetation and Productivity of Air-Dry Herbage (lbs./ac.)

WINDBREAK

Group	Adapted Trees to Plant	Tree Height Prediction at 20 Years Age	Relative Vigor

OTHER

USDA-SCS-LINCOLN, NEBR. 1973

SOIL CONSERVATION SERVICE

SOIL SURVEY INTERPRETATIONS [1]

STATE Missouri

MLRA 106, 107, 108, 109, 113, 114, 115.

The Wabash series consists of deep, very poorly drained, very slowly permeable soils. Typically, textures are silty clay throughout. The plow layer is very dark brown, the remainder of the surface and the subsoil is dominated by dark gray, very dark gray, or black colors. Wabash soils are in low areas of large flood plains. Slope gradients are less than 1 percent.

ESTIMATED SOIL PROPERTIES SIGNIFICANT TO ENGINEERING 2/

Major Soil Horizons (inches)	Classification			Coarse Fract. >3 in. %	Percentage less than 3 inches Passing Sieve No.--				LL	PI	Permeability in./hr.	Avail. Water Capac. in./in.	Soil Reaction pH	Shrink Swell Potential
	USDA Texture	Unified	AASHO		4	10	40	200						
0- 48	sic, c	CH	A-7-6	-	-	-	-	95-100	52-78	28-55	<0.06	.09-.13	5.6-7.8 (less acid with depth)	Very High

Flooding Occasional to frequent, mostly late winter or early spring.

Hydrologic group: D

Depth to water table: At or near surface winter and spring

Depth to bedrock: More than 6 feet

Corrosivity - uncoated steel: High

Corrosivity - concrete: Moderate

SUITABILITY OF SOIL AS SOURCE OF SELECTED MATERIAL AND FEATURES AFFECTING USE

Roadfill	Poor- Very high shrink-swell potential
Sand	Improbable source
Gravel	Improbable source
Topsoil	Poor- Silty clay texture

DEGREE AND KIND OF SOIL LIMITATION FOR SELECTED USES

Septic Tank Filter Fields	Severe- very slow permeable floods
Sewage Lagoons	Severe- flooding
Shallow Excavations	Severe- drainage, flooding
Dwellings: With Basements	Severe- drainage class, seasonal water table, flooding, shrink-swell
Without Basements	Severe- drainage class, seasonal water table, flooding, shrink-swell
Sanitary Landfill (trench & area types)	Severe- wetness, flooding. (cover material)- Severe- texture, wetness makes manipulation difficult
Local Roads and Streets	Severe- wetness, flooding, very high shrink-swell potential
Potential Frost Action	

MAJOR SOIL FEATURES AFFECTING SELECTED USES

Pond Reservoir Areas	Very slowly permeable, seasonal high water table
Embankments, Dikes, and Levees	Clayey material, high volume change, poor compaction characteristics
Drainage of Cropland and Pasture	Overflows, very slowly permeable, seasonally high water table
Irrigation	Low to moderate available water capacity, very slow intake rate
Terraces and Diversions	bottom land
Grassed Waterways	bottom land

1/ Use in conjunction with Guide to Soil Survey Interpretation Sheets.

2/ Based partly on data published in the Worth County, Missouri Soil Survey. Classification of material from 0 to 20 inch depth will be different for minor phases.

DEGREE OF SOIL LIMITATION AND MAJOR FEATURES AFFECTING RECREATION USES

Camp Areas	Severe- wetness, flooding	Golf Fairways	Severe- wetness
Picnic Areas	Severe- wetness, flooding	Cabin Sites	Severe- wetness, flooding
Playgrounds	Severe- wetness, flooding		
Paths and Trails	Severe- wetness, surface texture		

CAPABILITY, SOIL LOSS FACTORS, AND POTENTIAL YIELDS--(High level management)

Phases of Series	Capability	Soil Loss K	Soil Loss T	Corn	Soybeans	Wheat	Grass & Clover
				bu.	bu.	bu.	lbs.
Silty clay	IIIw	-	-	80	35	25	4,000

PASTURELAND AND HAYLAND

Phases of Series	Group	Species, Yield in AUMs for Dryland (Irrigated) Forage Production

WILDLIFE HABITAT SUITABILITY

Phases of Series	Potential for--							Potential for--		
	Grain and Seed Crops	Grasses, Legumes	Wild Herbaceous Plants	Hardwood Trees and Shrubs	Coniferous Plants	Wetland Food and Cover	Shallow Water Devel.	Openland Wildlife	Woodland Wildlife	Wetland Wildlife
All	Fair	Fair	Fair	Fair	Fair	Good	Good	Fair	Fair	Good

WOODLAND SUITABILITY

Phases of Series	Ordination	Potential Productivity		Woodland Management Hazards				Suitable Species		Other
		Important Trees	Site Index	Erosion Hazard	Equipment Limitations	Seeding Mortality	Plant Competition	To Favor	To Plant	
sic, c	5w3	Pin Oak Pecan	50 50	Slight	Severe	Moderate	Severe	Pin Oak Pecan	Pecan Cotton-wood	

RANGE

Phases of Series	Range Site Name	Climax Vegetation and Productivity of Air-Dry Herbage (lb./ac.)

WINDBREAK

Group	Adapted Trees to Plant	Tree Height Prediction at 20 Years Age	Relative Vigor

OTHER

USDA-SCS-LINCOLN, NEBR. 1974

Haplaquoll

(1)

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SOILS-73 (Rev. 1)
Attachment

SOIL SURVEY INTERPRETATIONS

MLRA(S) 108, 114, 115 | KIND OF UNIT SERIES | UNIT NAME DARWIN

STATE ILLINOIS | RECORD NO 51 | AUTHOR(S) KEL | DATE 3-75 | REVISED | QUALIFIER

CLASSIFICATION AND BRIEF SOIL DESCRIPTION

THE DARWIN SERIES CONSISTS OF POORLY TO VERY POORLY DRAINED SOILS FORMED IN CLAYEY ALLUVIUM ON FLOODPLAINS WHICH HAVE 0 TO 2 PERCENT SLOPES. TYPICALLY THEY HAVE VERY DARK GRAY SILTY CLAY SURFACE LAYERS ABOUT 14 INCHES THICK. [illegible] GRAY SILTY CLAY ABOUT [illegible] DARWIN SOILS HAVE SLOW [illegible]

DEPTH (IN.)	USDA TEXTURE	UNIFIED	AASHO	FRACT. >3 IN. (PCT)	PERCENT OF MATERIAL LESS THAN 3" PASSING SIEVE NO. 4	10	40	200	LIQUID LIMIT	PLAS. INDEX
0-56	SIC, C	CH	A-7	0	100	100	100	95-100	50-53	31-55
56-68	SICL, SIC	CL, CH	A-7, A-6	0	100	100	95-100	90-100	38-70	25-42

DEPTH (IN.)	PERMEABILITY (IN/HR)	AVAILABLE WATER CAPACITY (IN/IN)	SOIL REACTION (pH)	SALINITY (MMHOS/CM)	SHRINK-SWELL POTENTIAL	CORROSIVITY STEEL	CORROSIVITY CONCRETE	EROSION FACTORS K	T	WIND EROD. GROUP
SAME DEPTH AS ABOVE	<0.06	.11-.14	6.1-7.8	—	V. HIGH	—	LOW	—	—	4
	0.06-0.2	.10-.20	7.3-7.4	—	HIGH	—	LOW	—		

FLOODING FREQUENCY	DURATION	MONTHS	HIGH WATER TABLE DEPTH (FT)	KIND	MONTHS	CEMENTED PAN DEPTH (IN)	HARDNESS	BEDROCK DEPTH (IN)	HARDNESS	SUBSIDENCE INITIAL (IN)	TOTAL (IN)	HYD GRP	POTENTIAL FROST ACTION
FREQUENT	LONG	MAR-JUN	0-2	APPARENT	MAR-JUN	—		>60		—		D	HIGH

SANITARY FACILITIES	
SEPTIC TANK ABSORPTION FIELDS	SEVERE - PERCS SLOWLY, WET, FLOODS
SEWAGE LAGOONS	SEVERE - WET, FLOODS
SANITARY LANDFILL (TRENCH)	SEVERE - WET, FLOODS, TOO CLAYEY
SANITARY LANDFILL (AREA)	SEVERE - WET, FLOODS
DAILY COVER FOR LANDFILL	POOR - TOO CLAYEY, WET

SOURCE MATERIAL	
ROADFILL	POOR - SHRINK-SWELL, FROST ACTION, WET
SAND	UNSUITED
GRAVEL	UNSUITED
TOPSOIL	POOR - TOO CLAYEY, WET

COMMUNITY DEVELOPMENT	
SHALLOW EXCAVATIONS	SEVERE - WET, TOO CLAYEY, FLOODS
DWELLINGS WITHOUT BASEMENTS	SEVERE - FLOODS, SHRINK-SWELL, WET
DWELLINGS WITH BASEMENTS	SEVERE - FLOODS, SHRINK-SWELL, WET
SMALL COMMERCIAL BUILDINGS	SEVERE - FLOODS, SHRINK-SWELL, WET
LOCAL ROADS AND STREETS	SEVERE - WET, FROST ACTION, FLOODS

WATER MANAGEMENT	
POND RESERVOIR AREA	FAVORABLE
EMBANKMENTS DIKES AND LEVEES	HARD TO PACK, SHRINK-SWELL
EXCAVATED PONDS AQUIFER FED	FAVORABLE
DRAINAGE	PERCS SLOWLY, FLOODS
IRRIGATION	WET, SLOW INTAKE
TERRACES AND DIVERSIONS	NOT NEEDED
GRASSED WATERWAYS	NOT NEEDED

REGIONAL INTERPRETATIONS

UNIT NAME DARWIN
UNIT MODIFIER

(2)

RECREATION

CAMP AREAS	SEVERE - WET, FLOODS, PERCS SLOWLY	PLAYGROUNDS	SEVERE - WET, TOO CLAYEY
PICNIC AREAS	SEVERE - WET, TOO CLAYEY	PATHS AND TRAILS	SEVERE - WET

CLASS DETERMINING PHASE	CAPABILITY	CORN (BU)	SOYBEANS (BU)	WHEAT (BU)		GRASS-LEGUME HAY		FESCUE AUM
0-2%	3W	75	32	38	—	3.0		4.5

WOODLAND SUITABILITY

CLASS DETERMINING PHASE	ORD SYM	EROSION HAZARD	EQUIP. LIMIT	SEEDLING MORTAL.	WINDTH. HAZARD	PLANT COMPET.	IMPORTANT TREES	SITE INDEX	TREES TO PLANT
0-2%	3W	SLIGHT	SEVERE	SEVERE	SLIGHT	SEVERE	PIN OAK SWAMP WHITE OAK E. COTTONWOOD GREEN ASH SYCAMORE	75-85	E. COTTONWOOD SWEETGUM SYCAMORE GREEN ASH PIN OAK

WINDBREAKS

CLASS DETERMINING PHASE	SPECIES	HT	SPECIES	HT	SPECIES	HT	SPECIES
0-2%	AMUR MAPLE FORSYTHIA		SILKY DOGWOOD		FLOWERING DOGWOOD		AM. CRANBERRYBUSH

WILDLIFE HABITAT SUITABILITY

CLASS DETERMINING PHASE	GRAIN & SEED	GRASS & LEGUME	WILD HERB.	HARDWD TREES	CONIFER PLANTS	SHRUBS	WETLAND PLANTS	SHALLOW WATER	OPENLAND WILDLIFE	WOODLAND WILDLIFE	WETLAND WILDLIFE	RANGELAND WILDLIFE
0-2%	POOR	FAIR	FAIR	FAIR	POOR	—	GOOD	GOOD	FAIR	FAIR	GOOD	

POTENTIAL NATIVE PLANT COMMUNITY

COMMON PLANT NAME	PLANT SYMBOL

POTENTIAL PRODUCTION (LBS./AC. DRY WT.)
FAVORABLE YEARS
NORMAL YEARS
UNFAVORABLE YEARS

NOTES

A1 FOOTINGS PLACED BELOW FROST LINE
3 DRAINED AND LEVEE PROTECTED

Map Symbols
Illinois - 50 (silty clay loam surface)
47 (silt loam surface)

VIRDEN
Soil Series

SOIL INTERPRETATIONS

MLRA 108, 114, & 115 REV Date 10/71

BRIEF SOIL DESCRIPTION: The Virden series consists of poorly drained soils that have slopes of less than 2 percent on uplands. They have a black silty clay loam or silt loam surface layer and a gray heavy silty clay loam subsoil mottled with brownish yellow and olive brown. The underlying material is silt loam. Virden soils have a high organic matter content in the surface layer, moderately slow permeability in the subsoil, and a high to very high available water capacity. Surface water runoff is slow to ponded.

ESTIMATED PHYSICAL AND CHEMICAL PROPERTIES - Based on test data from Adams, Christian, and Jersey Counties, Illinois.

General Soil Profile	Classification			% of material passing sieve			Permeability inches per hour	Available water capacity in./in.	Soil reaction pH	Shrink-swell potential
	USDA Texture	Unified	AASHO	No. 4 5.0 mm	No. 10 2.0 mm	No. 200 0.074 mm				
	Surface layer Silty clay loam or silt loam 0 to 16 inches	CL	A-6 or A-7	100	100	95-100	0.63-2.00	.20-.25	6.1-7.3	Low to moderate
	Subsoil Heavy silty clay loam 16 to 49 inches	CH or CL	A-7	100	100	95-100	0.20-0.63	.19-.21	5.6-6.5	Moderate to high
	Underlying material Silt loam 49 to 60 inches	CL or ML	A-6	100	100	95-100	0.63-2.00	.18-.23	6.6-7.8	Low to moderate

Water Table: Less than 2 feet below the surface at least 2 months during the year (usually in the spring).
Hydrologic group: C Depth to rock: Greater than 6 feet.

SUITABILITY AND FEATURES AFFECTING SOIL AS RESOURCE MATERIAL		
Topsoil	Fair if remaining soil is not to be revegetated. Poor if remaining soil is to be revegetated - poorly drained; seasonal high water table.	
Sand and gravel	Not suitable.	
Road fill for highway subgrade	POOR:	Moderate to high shrink-swell potential in the subsoil; saturated with water in the spring; plastic index more than 25.

DEGREE OF LIMITATIONS AND SOIL FEATURES AFFECTING SELECTED USES 1		
Highway and street location	SEVERE:	Poorly drained; seasonal high water table; susceptible to frost heave; moderate to high shrink-swell potential in the subsoil.
Foundations for low buildings	SEVERE:	Poorly drained; seasonal high water table; moderate to high shrink-swell potential in the subsoil; subject to frost heave.
Pond reservoir areas	SLIGHT:	Has natural high water table and potential for dugout ponds.
Dams, dikes and embankments	MODERATE:	Poor to fair stability and compaction; slow permeability when compacted; medium to high compressibility; moderate to high shrink-swell in subsoil; material taken from below 4 feet is subject to piping.
Waterways	Generally not needed. Seasonal wetness hinders construction.	
Drainage	SEVERE:	Poorly drained; seasonal water table near surface; moderately slow permeability in the subsoil; surface runoff is slow with ponding in some places.
Terraces and diversions	Not needed.	
Irrigation	SEVERE:	Moderate intake rate; moderately slow permeability; high to very high water holding capacity; needs drainage prior to irrigation; slopes commonly less than 1 percent.
Corrosion of concrete	SLIGHT:	Low corrosion potential.

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE in cooperation with
ILLINOIS AGRICULTURAL EXPERIMENT STATION

National Cooperative Soil Survey - USA

INTERPRETATIONS FOR CROPLAND, PASTURE, AND WOODLAND

Cropland - general and specialty farm crops	Well suited to continuous row crops when adequately drained and properly managed. Used mainly for growing corn and soybeans.
Pasture	Seldom used for pasture but the soils are suited to a wide range of adapted grasses and legumes.
Woodland	No natural woodlands. Suitable species to plant: Pin oak, Green ash, Eastern larch.

PRINCIPAL MAP UNITS, CAPABILITY, AND YIELD PREDICTIONS - yields based on a high level of management

Principal Soil Map Units	Slope Range	Erosion Condition	Capability	Soil Loss K	Soil Loss T	Corn (bu)	Soybeans (bu)	Wheat (bu)	Oats (bu)	Legume-Grass Hay (tons)	Pasture (AUD)
47 and 50	0 to 2%	Uneroded	IIw	-	-	125	45	50	-	5.0	250

SUITABILITY FOR WILDLIFE

Openland wildlife	WELL SUITED in drained areas: Well suited to several species of wild herbaceous plants, hardwood woody plants, grain and seed crops, grasses, and legumes. POORLY SUITED in undrained areas: Poorly suited for growing grain and seed crops, grasses and legumes; natural establishment of wild herbaceous plants moderately limited.
Woodland wildlife	WELL SUITED in drained areas: No natural woodlands but well suited to the establishment of species of wild herbaceous plants and woody plants. SUITED in undrained areas: Limited production of herbaceous plants, grasses, and legumes.
Wetland wildlife	POORLY SUITED in drained areas: Number of suitable species of wetland food and cover plants severely limited. WELL SUITED in undrained areas: Well suited to several species of wetland food and cover plants, to shallow water developments.

LIMITATIONS FOR RECREATION 1/

Cottages and utility buildings	SEVERE:	Poorly drained; subject to ponding; seasonal high water table; moderate to high shrink-swell potential in the subsoil; subject to frost heave.
Tent and camp trailer sites	SEVERE:	Poorly drained; subject to ponding; seasonal high water table; dries slowly. Turf easily damaged when soil is wet.
Picnic areas	SEVERE:	Poorly drained; seasonal high water table; subject to ponding; dries slowly. Turf easily damaged when soil is wet.
Playgrounds	SEVERE:	Poorly drained; seasonal high water table; subject to ponding; dries slowly.
Paths and trails	SEVERE:	Poorly drained; seasonal high water table; subject to ponding; dries slowly
Golf course fairways	SEVERE:	Poorly drained; seasonal high water table; subject to ponding; dries slowly.

LIMITATIONS FOR SOME OTHER USES 1/

Residential, commercial and light industrial development with public sewers	SEVERE:	Frequent or continuous water saturation; slow or very slow runoff of surface water; may pond in some areas; excavations fill with water in the spring; slow to dry; wet basements probable; foundations, slabs, walks, and streets subject to cracking and heaving caused by frost heave and shrink-swell.
Septic tank filter fields	SEVERE:	Poorly drained; seasonal water table near surface; moderately slowly permeable in the subsoil; subject to ponding. Percolation rate estimated to be slower than 60 minutes per inch.
Sewage lagoons	SEVERE:	Upper 15 inches is high in organic matter content; subject to ponding; seasonal water table near surface.

1/ The soil is evaluated to a depth of five feet. Soils are rated on the basis of three classes of soil limitations: Slight - relatively free of limitations or limitations are easily overcome; Moderate - limitations need to be recognized, but can be overcome with correct planning and careful design; Severe - limitations are severe enough to make use questionable. (Severe may be further subdivided into Severe and Very Severe where needed.) Ratings may be changed as additional experience and data are obtained. <u>USE OF INFORMATION ON THIS SHEET DOES NOT ELIMINATE THE NEED FOR ON-SITE INVESTIGATIONS.</u>

Argiudoll

EEV-JAT

Map Symbols	MUSCATINE	MLRA 108	Date 2/71
Illinois - 41	Soil Series		

SOIL INTERPRETATIONS

BRIEF SOIL DESCRIPTION: The Muscatine series consists of somewhat poorly drained soils that have slopes of 0 to 3 percent on uplands and terraces. They have a black silt loam surface layer and a dark grayish brown silty clay loam subsoil. The underlying material is silt loam. Muscatine soils have a high organic matter content in the surface layer, moderate permeability, and a very high available water capacity. Surface water runoff is slow.

ESTIMATED PHYSICAL AND CHEMICAL PROPERTIES - Based on test data from Jersey County, Illinois

General Soil Profile	Classification			% of material passing sieve			Permeability inches per hour	Available water capacity in./in.	Soil reaction pH	Shrink-swell potential
	USDA Texture	Unified	AASHO	No. 4 5.0 mm	No. 10 2.0 mm	No. 200 0.074 mm				
	Surface layer Silt loam 0 to 16 inches	ML or CL	A-4 or A-6	100	100	95-100	0.63-2.00	.20-.25	5.1-6.5	Low
	Subsoil Silty clay loam 16 to 48 inches	CL or CH	A-7	100	100	95-100	0.63-2.00	.19-.21	5.6-6.5	Moderate
	Underlying material Silt loam 48 to 60 inches	CL	A-6 or A-4	100	100	95-100	0.63-2.00	.18-.23	6.6-7.8	Low

Water Table: Temporarily 1 to 3 feet below surface in the spring.
Hydrologic group: B Depth to rock: Greater than 6 feet.

SUITABILITY AND FEATURES AFFECTING SOIL AS RESOURCE MATERIAL	
Topsoil	Surface: Good - 14 to 20 inches of silt loam; high organic matter content. Subsoil: Fair - silty clay loam; sticky when wet and hard when dry.
Sand and gravel	Not suitable.
Road fill for highway subgrade	Subsoil: Poor - moderate shrink-swell; subject to frost heave; plastic index more than 20. Underlying material: Fair to poor - low shrink-swell; fair to poor compaction; plastic index 13 to 20.

DEGREE OF LIMITATIONS AND SOIL FEATURES AFFECTING SELECTED USES 1/		
Highway and street location	MODERATE:	Somewhat poorly drained; seasonal high water table; susceptible to frost heave; subsoil is plastic and has a moderate shrink-swell potential; material underlying subsoil has low shrink-swell.
Foundations for low buildings	MODERATE:	Somewhat poorly drained; seasonal high water table; subsoil has high compressibility and moderate shrink-swell potential; underlying material has low shrink-swell; susceptible to frost heave.
Pond reservoir areas	MODERATE:	Underlying material has moderate permeability; seepage hazard; has temporary seasonal high water table and potential for dugout ponds.
Dams, dikes and embankments	SLIGHT in subsoil - fair to good stability and compaction; good workability and resistance to piping. MODERATE in underlying material - fair to poor stability, compaction and resistance to piping; fair to good workability.	
Waterways	SLIGHT:	Wetness may hinder construction some seasons.
Drainage	MODERATE:	Somewhat poorly drained; water table temporarily 1 to 3 feet below surface in the spring; moderate permeability; surface runoff is slow.
Terraces and diversions	SLIGHT:	Generally not needed. Wetness may hinder construction some seasons.
Irrigation	MODERATE:	Moderate water intake rate; moderate permeability; very high water holding capacity; drainage needed in some places for maximum crop yields; high crop yield potential.
Corrosion of concrete	SLIGHT:	Low corrosion potential; medium acid to mildly alkaline.

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE in cooperation with
ILLINOIS AGRICULTURAL EXPERIMENT STATION

National Cooperative Soil Survey - USA

INTERPRETATIONS FOR CROPLAND, PASTURE, AND WOODLAND

Cropland - general and specialty farm crops	Well suited to commonly grown crops where adequately drained. Used mainly for growing corn and soybeans.
Pasture	Seldom used for pasture but is well suited to several species of adapted grasses and legumes.
Woodland	No natural woodlands. Suitable species to plant: Ash, White pine, Norway spruce, Red pine, Red maple

PRINCIPAL MAP UNITS, CAPABILITY, AND YIELD PREDICTIONS - yields based on a high level of management

Principal Soil Map Units	Slope Range	Erosion Condition	Capa-bility	Soil Loss K	Soil Loss T	Corn (bu)	Soybeans (bu)	Wheat (bu)	Oats (bu)	Legume-Grass Hay (tons)	Pasture (AUD)
41	0 to 3%	None	I	.32	5	140	48	58	85	5.8	290

SUITABILITY FOR WILDLIFE

Openland wildlife	WELL SUITED:	Well suited to several species of wild herbaceous upland plants, hardwood woody plants, grain and seed crops, and grasses and legumes.
Woodland wildlife	WELL SUITED:	Well suited to the establishment of several species of wild herbaceous upland plants and hardwood woody plants. Rapid growth of coniferous woody plants causes early canopy closure.
Wetland wildlife	SUITED:	Number of suitable plant species for wetland food and cover moderately limited; in-adequate water table for shallow water developments and dugout ponds during dry seasons.

LIMITATIONS FOR RECREATION 1/

Cottages and utility buildings	MODERATE:	Somewhat poorly drained; susceptible to frost heave; moderate shrink-swell potential in subsoil; material below subsoil has low shrink-swell.
Tent and camp trailer sites	MODERATE:	Somewhat poorly drained; seasonal water table at 1 to 3 feet; slow to dry.
Picnic areas	MODERATE:	Somewhat poorly drained; seasonal water table at 1 to 3 feet; slow to dry.
Playgrounds	MODERATE:	Somewhat poorly drained; seasonal water table at 1 to 3 feet; slow to dry.
Paths and trails	MODERATE:	Somewhat poorly drained; seasonal water table at 1 to 3 feet; slow to dry.
Golf course fairways	MODERATE:	Somewhat poorly drained; soft and wet in the spring; slow to dry.

LIMITATIONS FOR SOME OTHER USES 1/

Residential, commercial and light industrial development with public sewers	MODERATE:	Periodic water saturation; excavations may fill with water in the spring; wet basements probable; foundations, slabs, walks and streets subject to cracking because of frost heave and shrink-swell of subsoil.
Septic tank filter fields	MODERATE:	Severe in some areas. Moderate permeability; some areas periodically saturated with water at depths of 1 to 3 feet. Estimated percolation rate ranges from 45 to 60 minutes per inch.
Sewage lagoons	MODERATE:	Moderate permeability; seasonal water table temporarily at depths of 1 to 3 feet; surface layer poor for embankment material and floor of lagoon because of high organic matter content.

1/ The soil is evaluated to a depth of five feet. Soils are rated on the basis of three classes of soil limitations: Slight - relatively free of limitations or limitations are easily overcome; Moderate - limitations need to be recognized, but can be overcome with correct planning and careful design; Severe - limitations are severe enough to make use questionable. (Severe may be further subdivided into Severe and Very Severe where needed.) Ratings may be changed as additional experience and data are obtained. USE OF INFORMATION ON THIS SHEET DOES NOT ELIMINATE THE NEED FOR ON-SITE INVESTIGATIONS.

[illegible], 1971

APPENDIX B

WATER QUALITY

INDEX - APPENDIX B

Table 1.

Statistical Analysis of Physical and Chemical Data from Side Channel; Pool 24, 25, and 26; Mississippi River; 1974.

Variable	July 1974 $\bar{X}$	July 1974 SD	July 1974 No. Obs	September 1974 $\bar{X}$	September 1974 SD	September 1974 No. Obs	Both Periods $\bar{X}$	Both Periods SD	Both Periods No. Obs
Physiochemical (Surface):									
Dissolved Oxygen (DO), mg/ℓ	6.5	0.6	12	9.5	2.3	12	7.9	2.2	23
Temperature, °C	26.3	2.1	11	21.2	1.8	10	23.9	3.3	21
Turbidity, JTU	215.9	128.6	12	61.3	31.1	12	138.6	120.9	24
pH	7.7	0.2	12	8.1	0.3	12	7.9	0.3	24
Total Alkalinity, mg/ℓ	140.8	11.5	12	177.8	35.2	12	159.3	31.8	24
Physiochemical (Bottom):									
Dissolved Oxygen (DO), mg/ℓ	5.1	2.2	8	10.0	2.0	9	7.7	3.2	17
Temperature, °C	24.8	2.5	6	21.0	2.3	8	22.6	3.0	14
Turbidity, JTU	236.3	133.6	10	59.0	30.5	9	152.3	132.7	19
pH	7.6	0.2	10	8.1	0.4	9	7.8	0.4	19
Total Alkalinity, mg/ℓ	142.6	11.5	10	182.7	38.9	9	161.6	34.1	19
Physical Measurements:									
Current Velocity, fps	1.2	1.1	3	0.0	0.0	1	0.9	1.1	4
Settleable Solids, ml/ℓ	0.4	0.3	11	0.1	0.0	9	0.3	0.3	20
Secchi Disk, cm	14.1	9.0	3	32.1	9.9	12	28.5	12.0	15
Depth, m	3.0	2.1	12	2.0	1.9	12	2.5	2.0	24
Sediment Chemistry (All units mg/kg):									
Nitrate Nitrogen NO_3, N	18.9	6.5	5	-	-	-	18.9	6.5	5
Nitrite Nitrogen NO_2,N	2.2	0.3	5	-	-	-	2.2	0.3	5
Ammonia Nitrogen NH_3,N	10.7	11.5	5	0.1	0.03	8	4.2	8.6	13
Total Phosphorus	64.2	24.8	5	535.9	285.3	8	354.4	323.6	13
Total Kjeldahl Nitrogen (TKN)	677.6	663.8	5	940.1	685.0	8	839.2	662.0	13
Arsenic As	3.0	1.9	5	-	-	-	3.0	1.9	5
Iron Fe	6375.0	3447.8	5	17,631.3	11,287.6	8	13,378.8	10,470.4	13
Manganese Mn	262.7	235.0	5	503.1	312.0	8	410.7	300.0	13
Lead Pb	6.8	5.0	5	11.8	9.4	8	9.9	8.1	13
Cadmium Cd	0.3	0.1	5	0.7	0.4	8	0.5	0.4	13
Zinc Zn	93.7	100.3	5	60.7	41.3	8	73.4	68.0	13
Mercury Hg	0.04	0.03	5	0.07	0.04	8	0.1	0.04	13
Chemical Oxygen Demand (COD)	2350.0	2142.6	5	30,133.8	22,040.2	8	19,447.7	21,973.4	13
Cyanide	0.1	0.06	5	0.04	0.01	8	0.1	0.1	13
Phenol	0.06	0.02	5	0.05	0.03	8	0.1	0.02	13
Total Organic Carbon (TOC)	4052.6	3360.6	5	11,291.3	8275.1	8	8507.2	7559.4	13
Nitrate + Nitrite Nitrogen NO_3,N + NO_2, N	-	-	-	1.2	0.0	8	1.2	0.0	8
Water Chemistry (mg/ℓ unless noted):									
Nitrate Nitrogen NO_3,N	0.6	0.1	5	-	-	-	0.6	0.1	5
Nitrite Nitrogen NO_2,N	0.1	0.02	5	-	-	-	0.1	0.02	5
Ammonia Nitrogen NH_3,N	0.7	0.3	5	0.06	0.02	8	0.3	0.3	13
Total Phosphorus	1.4	0.1	5	0.2	0.03	8	0.6	0.6	13
Total Kjeldahl Nitrogen (TKN)	0.9	0.2	5	0.7	0.1	8	0.8	0.2	13
Arsenic As	0.004	0.001	5	-	-	-	0.004	0.001	5
Iron Fe	2.3	1.3	5	1.4	0.4	8	1.7	0.9	13
Manganese Mn	0.4	0.2	5	0.3	0.6	8	0.4	0.4	13
Lead Pb, µg/ℓ	4.2	1.3	5	50.0	0.0	8	32.4	23.2	13
Cadmium Cd, µg/ℓ	1.0	0.0	5	5.0	0.0	8	3.5	2.0	13
Zinc Zn	0.03	0.01	5	0.04	0.02	8	0.04	0.02	13
Mercury Hg, µg/ℓ	4.8	7.7	5	1.5	1.6	8	2.8	4.9	13
Chemical Oxygen Demand (COD)	33.4	8.0	5	19.1	13.7	8	24.6	13.5	13
Cyanide	0.01	0.0	5	0.0	0.0	8	0.004	0.005	13
Phenol	0.02	0.03	5	0.004	0.0	8	0.009	0.02	13
Total Organic Carbon (TOC)	6.9	3.3	5	-	-	-	6.9	3.3	5
Nitrate + Nitrite Nitrogen NO_3,N + NO_2,N	-	-	-	0.8	0.3	7	0.8	0.3	7

NOTE:
$\bar{X}$ = mean value
SD = standard deviation
No. obs = number of observations
\- indicates no sample taken

Table 2.

Statistical Analysis of Physical and Chemical Data from Main Channel; Pool 24, 25, and 26: Mississippi River: 1974.

Variable	July 1974 $\bar{X}$	July 1974 SD	July 1974 No. Obs	September 1974 $\bar{X}$	September 1974 SD	September 1974 No. Obs	Over Periods $\bar{X}$	Over Periods SD	Over Periods No. Obs
Physicochemical (Surface):									
Dissolved Oxygen (DO), mg/l	6.[illegible]	[illegible]	13	9.2	0.9	13	8.0	1.4	
Temperature, °C	25.7	1.1	13	21.9	0.9	13	23.8	2.2	[illegible]
Turbidity, JTU	282.3	117.7	13	36.[illegible]	6.2	13	159.6	149.4	26
pH	7.[illegible]	0.1	13	[illegible]	0.2	13	7.[illegible]	0.3	26
Total Alkalinity, mg/l	140.5	15.5	13	155.8	6.2	13	153.2	16.9	26
Physicochemical (Bottom):									
Dissolved Oxygen (DO), mg/l	6.[illegible]	0.5	13	9.1	1.1	12	7.9	1.5	25
Temperature, °C	25.6	1.1	13	21.7	0.8	13	23.7	2.2	26
Turbidity, JTU	290.2	115.0	13	47.1	13.1	12	173.5	148.9	25
pH	7.7	0.1	13	7.9	0.4	13	7.8	0.3	26
Total Alkalinity, mg/l	139.0	10.5	13	166.5	5.0	13	152.7	16.1	26
Physical Measurements:									
Current Velocity, fps	2.[illegible]	1.3	12	1.3	0.4	13	1.8	1.1	25
Settleable Solids, ml/l	0.5	0.5	13	0.1	0.03	13	.3	.4	26
Secchi Disk, cm	-	-	-	39.3	8.5	11	39.3	8.5	11
Depth, m	7.5	1.5	13	3.1	1.6	13	6.8	1.7	26
Sediment Chemistry (All units mg/kg):									
Nitrate Nitrogen NO_3, N	13.3	3.7	11	-	-	-	13.3	3.7	11
Nitrite Nitrogen NO_2, N	2.0	0.4	11	-	-	-	2.0	0.4	11
Ammonia Nitrogen NH_3, N	5.0	1.7	11	0.1	0.2	13	2.4	2.7	24
Total Phosphorus	67.[illegible]	25.2	11	187.1	54.2	13	132.2	74.4	24
Total Kjeldahl Nitrogen (TKN)	78.1	105.2	11	55.5	54.5	13	65.8	80.6	24
Arsenic As	2.2	1.4	11	-	-	-	2.2	1.4	11
Iron Fe	4864.1	2195.3	11	6896.2	1725.3	13	5955.6	2177.0	24
Manganese Mn	173.0	116.7	11	178.4	55.3	13	176.0	86.8	[illegible]
Lead Pb	2.8	0.7	11	2.3	0.5	13	2.5	0.7	[illegible]
Cadmium Cd	0.2	0.1	11	0.3	0.1	13	0.3	0.2	[illegible]
Zinc Zn	43.7	71.8	11	14.2	3.4	13	27.8	21.0	[illegible]
Mercury Hg	0.1	0.03	11	0.04	0.1	13	0.1	0.05	24
Chemical Oxygen Demand (COD)	282.3	237.8	11	1127.7	1056.2	13	740.2	896.2	24
Cyanide	0.1	0.03	11	0.03	0.006	13	0.1	0.04	24
Phenol	0.1	0.1	10	0.03	0.006	13	0.06	0.09	23
Total Organic Carbon (TOC)	1319.[illegible]	1428.4	11	424.5	396.8	13	834.7	1084.8	24
Nitrate + Nitrite Nitrogen NO_3,N + NO_2,N	-	-	-	1.2	0.0	13	1.2	0.0	13
Water Chemistry (mg/l unless noted):									
Nitrate Nitrogen NO_3, N	0.8	0.3	12	-	-	-	0.8	0.3	12
Nitrite Nitrogen NO_2, N	0.1	0.03	12	-	-	-	0.1	0.03	12
Ammonia Nitrogen NH_3, N	0.[illegible]	[illegible]	12	0.2	0.02	13	[illegible]	0.4	25
Total Phosphorus	1.3	0.3	12	0.2	0.02	13	0.7	0.6	25
Total Kjeldahl Nitrogen (TKN)	1.1	0.5	12	0.8	0.1	13	0.9	0.4	25
Arsenic As	0.004	0.002	11	-	-	-	0.004	0.002	11
Iron Fe	3.5	1.9	12	1.1	0.2	13	2.2	1.[illegible]	25
Manganese Mn	0.3	0.1	12	0.1	0.03	13	0.2	0.1	25
Lead Pb, µg/l	6.4	4.7	12	50.0	0.0	13	29.1	22.5	25
Cadmium Cd, µg/l	1.0	0.0	12	5.0	0.0	13	3.1	2.0	25
Zinc Zn	0.03	0.01	12	0.1	0.1	13	0.06	0.05	25
Mercury Hg, µg/l	4.5	5.1	11	0.8	0.7	12	2.6	3.9	23
Chemical Oxygen Demand (COD)	40.5	6.0	11	16.3	4.3	12	27.9	13.3	23
Cyanide	0.01	0.0	11	0.0	0.0	13	0.005	0.005	24
Phenol	0.01	0.02	11	0.01	0.002	13	0.007	0.01	24
Total Organic Carbon (TOC)	8.1	3.0	12	-	-	-	8.1	3.0	12
Nitrate + Nitrite Nitrogen NO_3,N + NO_2,N	-	-	-	1.0	0.2	13	1.0	0.2	13

NOTE: $\bar{X}$ = mean value
SD = standard deviation
No. Obs = number of observations
- indicates no sample taken

Table 3.

Statistical Analysis of Physical and Chemical Data from River Border Areas; Pool 24, 25, and 26; Mississippi River; 1974

Variable	July 1974 $\bar{X}$	July 1974 SD	July 1974 No. Obs	September 1974 $\bar{X}$	September 1974 SD	September 1974 No. Obs	Over Periods $\bar{X}$	Over Periods SD	Over Periods No. Obs
Physicochemical (surface):									
Dissolved Oxygen (DO), mg/l	6.6	0.4	12	9.1	0.7	13	7.9	1.4	25
Temperature, °C	25.9	1.4	12	22.0	1.0	13	23.9	2.3	25
Turbidity, JTU	280.4	136.7	12	40.0	14.3	13	155.4	153.9	25
pH	7.7	0.2	12	8.1	0.3	13	7.9	0.3	25
Total Alkalinity, mg/l	139.1	13.5	12	166.2	4.9	13	153.2	16.9	25
Physicochemical ([illegible]):									
Dissolved Oxygen (DO), mg/l	6.5	0.3	12	9.0	0.6	9	7.5	1.4	21
Temperature, °C	25.8	1.3	12	21.7	1.0	8	24.2	2.4	20
Turbidity, JTU	274.5	125.2	12	40.0	9.0	9	174.0	151.0	21
pH	7.7	0.2	12	8.2	0.2	9	7.9	0.3	21
Total Alkalinity, mg/l	139.8	13.3	12	167.5	5.6	8	150.9	17.6	20
Physical Measurements:									
Current Velocity, [illegible]	2.2	1.0	12	0.9	0.7	11	1.6	1.1	23
Settliable Solids, ml/l	0.5	0.4	10	0.1	0.03	11	0.3	0.3	21
Secchi Disk, cm	7.6	0.0	1	44.0	11.4	13	41.4	14.7	14
Depth, [illegible]	7.5	1.5	13	3.2	2.5	13	4.5	2.9	25

Note: $\bar{X}$ = mean value
SD = standard deviation
No. obs = number of observations
\- indicates no sample taken

Table 4.

Statistical Analysis of Physical and Chemical Data from Dikes; Pool 24; 25; and 26; Mississippi River; 1974.

Variable	July 1974 $\bar{X}$	July 1974 SD	July 1974 No. Obs	September 1974 $\bar{X}$	September 1974 SD	September 1974 No. Obs	Over Periods $\bar{X}$	Over Periods SD	Over Periods No. Obs
Physicochemical (Surface):									
Dissolved Oxygen (DO), mg/l	6.6	0.6	11	9.3	0.9	11	8.0	1.6	22
Temperature, °C	26.3	1.4	11	21.9	0.8	1	24.1	2.5	22
Turbidity, JTU	248.0	108.9	11	48.2	12.6	10	152.9	128.3	21
pH	7.6	0.2	11	8.2	0.3	11	7.9	0.4	22
Total alkalinity, mg/l	133.5	15.8	11	168.2	5.7	11	150.9	21.2	22
Physicochemical (Bottom):									
Dissolved Oxygen (DO), mg/l	6.5	0.3	9	9.0	1.1	7	7.6	1.5	16
Temperature, °C	26.0	1.4	9	21.7	0.9	7	24.1	2.5	16
Turbidity, JTU	275.0	83.4	10	65.6	30.7	7	188.8	126.7	17
pH	7.6	0.2	10	8.3	0.2	6	7.9	0.4	16
Total alkalinity, mg/l	134.9	16.4	10	166.7	4.8	7	148.0	20.5	17
Physical Measurements:									
Current Velocity, fps	1.9	0.9	8	0.6	0.5	10	1.2	0.8	18
Settleable Solids, ml/l	0.4	0.4	11	0.1	0.03	11	0.3	0.3	22
Secchi Disk, cm	3.8	0.0	1	37.5	8.1	11	34.7	12.4	12
Depth, m	4.4	2.4	11	1.9	1.5	11	3.2	2.3	22

Note: $\bar{X}$ = mean value
SD = standard deviation
No. obs = number of observations
\- indicates no sample taken

Table 5.

Statistical Analysis of Physical and Chemical Data From Main Channel, Lower Illinois River, 1974.

Variable	July 1974 $\bar{X}$	July 1974 SD	July 1974 No. Obs	September 1974 $\bar{X}$	September 1974 SD	September 1974 No. Obs	Over Periods $\bar{X}$	Over Periods SD	Over Periods No. Obs
Physicochemical (Surface):									
Dissolved Oxygen (DO), mg/l	5.6	0.3	6	8.2	0.7	6	6.9	1.5	12
Temperature, °C	26.2	1.2	6	21.4	1.1	5	24.0	2.7	11
Turbidity, JTU	144.5	41.2	6	90.0	17.9	6	117.3	41.[illegible]	12
pH	7.6	0.1	6	7.7	0.1	6	7.7	0.1	12
Total Alkalinity, mg/l	153.5	20.1	6	197.5	7.1	6	175.5	27.1	12
Physicochemical (Bottom):									
Dissolved Oxygen (DO), mg/l	5.7	0.5	2	8.1	0.7	6	7.5	1.3	8
Temperature, °C	25.0	1.5	2	21.0	0.8	6	22.0	2.0	8
Turbidity, JTU	185.0	21.2	2	117.5	30.9	6	134.4	41.5	8
pH	7.8	0.4	2	7.8	0.1	6	7.8	0.2	8
Total Alkalinity, mg/l	139.5	36.1	2	200.8	12.6	6	185.5	33.2	8
Physical Measurements:									
Current Velocity, fps	1.9	0.8	6	1.3	0.5	6	1.6	0.7	12
Settleable Solids, ml/l	0.2	0.1	6	0.1	0.0	6	0.1	0.06	12
Secchi Disk, cm	-	-	-	24.5	6.1	6	24.5	6.1	6
Depth, m	7.7	1.2	5	5.2	1.9	6	6.3	2.0	11
Sediment Chemistry (All units mg/kg):									
Nitrate Nitrogen NO_3, N	14.6	2.1	5	-	-	-	14.6	2.1	5
Nitrite Nitrogen NO_2, N	2.1	0.2	5	-	-	-	2.1	0.2	5
Ammonia Nitrogen NH_3, N	52.9	109.1	5	0.1	0.02	5	26.5	77.9	10
Total Phosphorus	137.1	48.3	5	392.4	195.0	5	264.7	189.9	10
Total Kjeldahl Nitrogen (TKN)	243.3	365.2	5	348.0	369.3	5	295.7	350.7	10
Arsenic As	6801.4	3895.8	5	-	-	-	6801.4	3895.8	5
Iron Fe	4607.0	2648.9	5	9110.0	5294.3	5	6858.5	4605.3	10
Manganese Mn	232.2	119.0	5	454.4	243.0	5	343.3	215.1	10
Lead Pb	3.5	1.7	5	4.6	3.2	5	4.0	2.5	10
Cadmium Cd	0.8	1.0	5	0.5	0.2	5	0.6	0.7	10
Zinc Zn	64.9	19.3	5	32.7	24.0	5	48.8	26.6	10
Mercury Hg	0.06	0.03	5	0.1	0.1	5	0.1	0.1	10
Chemical Oxygen Demand (COD)	803.6	563.7	5	12514.0	12220.8	5	6658.8	10227.9	10
Cyanide	0.1	0.04	5	0.03	0.0	3	0.09	0.06	8
Phenol	0.1	0.02	4	0.03	0.01	4	0.04	0.02	8
Total Organic Carbon (TOC)	2131.8	1813.9	5	4674.0	4580.0	5	3402.9	3546.9	10
Nitrate + Nitrite Nitrogen NO_3,N + NO_2, N	-	-	-	1.2	0.0	5	1.6	1.0	9
Water Chemistry (mg/l unless noted):									
Nitrate Nitrogen NO_3,N	1.4	0.3	5	-	-	-	1.4	0.3	5
Nitrite Nitrogen NO_2,N	0.1	0.03	5	-	-	-	0.1	0.03	5
Ammonia Nitrogen NH_3,N	0.7	0.2	5	0.1	0.03	5	0.4	0.3	10
Total Phosphorus	1.4	0.1	5	0.5	0.1	5	0.9	0.5	10
Total Kjeldahl Nitrogen (TKN)	1.02	0.3	5	0.8	0.1	5	0.9	0.2	10
Arsenic As	0.003	0.0	5	-	-	-	0.003	0.00	5
Iron Fe	1.3	0.4	5	2.7	0.7	5	2	0.9	10
Manganese Mn	0.1	0.02	5	0.2	0.03	5	0.1	0.03	10
Lead Pb, ug/l	3.8	0.8	5	50.0	0.0	5	26.9	24.9	10
Cadmium Cd, ug/l	1.0	0.0	5	5.0	0.0	5	3	2.1	10
Zinc Zn	0.03	0.01	5	0.06	0.02	5	0.04	0.02	10
Mercury Hg, ug/l	3.2	5.7	5	1.02	1.1	5	2.1	4.0	10
Chemical Oxygen Demand (COD)	23.8	6.8	4	18.5	6.2	4	21.1	6.1	8
Cyanide	0.01	0.0	5	0.0	0.0	5	0.005	0.005	10
Phenol	0.02	0.03	5	0.01	0.004	5	0.01	0.02	10
Total Organic Carbon (TOC)	4.3	1.7	5	-	-	-	4.3	1.7	5
Nitrate + Nitrite Nitrogen NO_3,N + NO_2,N	-	-	-	2.5	0.2	5	2.5	0.2	5

NOTE: $\bar{X}$ = mean value
SD = standard deviation
No. obs = number of observations
\- indicates no sample taken

Table 6.

Statistical Analysis of Physical and Chemical Data from Side Channel, Lower Illinois River, 1974.

Variable	July 1974 $\bar{X}$	July 1974 SD	July 1974 No. Obs	September 1974 $\bar{X}$	September 1974 SD	September 1974 No. Obs	Over Period $\bar{X}$	Over Period SD	Over Period No. Obs
Physiochemical (Surface):									
Dissolved Oxygen (DO), mg/l	5.5	0.0	2	8.6	0.3	3	7.4	1.7	5
Temperature, °C	26.8	1.0	3	20.7	1.8	3	23.8	3.6	6
Turbidity, JTU	122.0	19.7	3	95.7	15.3	3	109.3	21.0	6
pH	7.5	0.3	3	7.7	0.2	3	7.6	0.2	6
Total Alkalinity, mg/l	161.3	1.5	3	201.0	0.0	3	181.2	21.7	6
Physiochemical (Bottom):									
Dissolved Oxygen (DO), mg/l	5.6	0.1	2	8.1	1.2	2	6.8	1.6	4
Temperature, °C	27.0	0.0	1	20.8	0.4	2	22.8	3.6	3
Turbidity, JTU	134.5	29.0	2	90.0	14.1	2	112.3	31.7	4
pH	7.7	0.1	2	7.5	0.0	2	7.6	0.1	4
Total Alkalinity, mg/l	164.0	2.8	2	201.0	0.0	2	182.5	21.4	4
Physical Measurements:									
Current Velocity, fps	1.9	0.0	1	0.9	0.0	1	1.4	0.7	2
Settleable Solids, ml/l	0.1	0.1	3	0.1	0.1	3	0.1	0.05	6
Secchi Disk, cm	-	-	-	21.0	4.6	3	21.0	4.6	3
Depth, m	3.8	2.3	3	2.5	2.3	3	3.2	2.2	6
Sediment Chemistry (All units mg/kg):									
Nitrate Nitrogen NO_3, N	20.3	3.7	2	-	-	-	20.3	3.7	2
Nitrite Nitrogen NO_2,N	2.3	0.3	2	-	-	-	2.3	0.3	2
Ammonia Nitrogen NH_3,N	95.3	66.0	2	0.1	0.01	2	47.7	67.0	4
Total Phosphorus	16.8	6.0	2	705.0	120.2	2	360.9	403.3	4
Total Kjeldahl Nitrogen (TKN)	889.0	92.0	2	1105.0	332.3	2	997.0	234.9	4
Arsenic As	500.0	707.1	2	-	-	-	500.0	707.1	2
Iron Fe	15556.5	3915.3	2	21250.0	1626.3	2	18403.3	4098.4	4
Manganese Mn	311.4	234.9	2	599.0	8.5	2	455.2	214.4	4
Lead	12.3	1.1	2	13.1	5.9	2	12.7	3.5	4
Cadmium Cd	0.5	0.02	2	0.7	0.1	2	0.6	0.08	4
Zinc Zn	90.8	18.7	2	78.3	18.5	2	84.5	16.8	4
Mercury Hg	0.02	0.02	2	0.1	0.1	2	0.07	0.08	4
Chemical Oxygen Demand (COD)	8424.5	1177.3	2	29600.0	1555.6	2	19012.3	12277.5	4
Cyanide	0.2	0.0	1	0.04	0.0	2	0.09	0.09	3
Phenol	0.1	0.03	2	0.03	0.0	1	0.05	0.03	3
Total Organic Carbon (TOC)	6434.0	514.8	2	11100.0	565.7	2	8777.0	2718.5	4
Nitrate + Nitrite Nitrogen NO_3,N + NO_2, N	-	-	-	1.2	0.0	2	3.1	3.9	4
Water Chemistry (mg/l unless noted):									
Nitrate Nitrogen NO_3,N	1.0	0.1	2	-	-	-	1.0	0.1	2
Nitrite Nitrogen NO_2,N	0.1	0.0	2	-	-	-	0.1	0.0	2
Ammonia Nitrogen NH_3,N	0.4	0.0	2	0.1	0.01	2	0.2	0.2	4
Total Phosphorus	1.4	0.1	2	0.5	0.1	2	0.9	0.5	4
Total Kjeldahl Nitrogen (TKN)	0.8	0.5	2	0.8	0.2	2	0.8	0.3	4
Arsenic As	0.003	0.001	2	-	-	-	0.003	0.001	2
Iron Fe	1.3	0.1	2	2.8	0.5	2	2.0	0.9	4
Manganese Mn	0.1	0.0	2	0.2	0.01	2	0.2	0.02	4
Lead Pb, ug/l	3.5	0.7	2	50.0	0.0	2	26.8	26.9	4
Cadmium, Cd, ug/l	1.0	0.0	2	5.0	0.0	2	3.0	2.3	4
Zinc Zn	0.03	0.01	2	0.1	0.03	2	0.05	0.03	4
Mercury Hg, ug/l	0.5	0.0	2	0.1	0.0	2	0.3	0.2	4
Chemical Oxygen Demand (COD)	76.5	71.4	2	20.0	0.0	1	57.7	60.1	3
Cyanide	0.02	0.0	1	0.0	0.0	2	0.007	0.01	3
Phenol	0.004	0.0	2	0.004	0.0	2	0.004	0.0	4
Total Organic Carbon (TOC)	6.8	1.8	2	-	-	-	6.8	1.8	2
Nitrate + Nitrite Nitrogen NO_3,N + NO_2,N	-	-	-	2.8	0.2	2	2.8	0.2	2

NOTE: $\bar{X}$ = mean value
SD = standard deviation
No. obs = number of observation
\- indicates no sample taken

Table 7.

Statistical Analysis of Physical and Chemical Data from Dike, Lower Illinois River, 1974

Variable	July 1974 $\bar{X}$	July 1974 SD	July 1974 No. Obs	September 1974 $\bar{X}$	September 1974 SD	September 1974 No. Obs	Over Period $\bar{X}$	Over Period SD	Over Period No. Obs
Physicochemical (Surface):									
Dissolved Oxygen (DO), mg/l	5.6	0.0	1	8.6	0.0	1	7.2	2.2	2
Temperature, °C	27.5	0.0	1	22.5	0.0	1	25.0	3.5	2
Turbidity, JTU	160.0	0.0	1	115.0	0.0	1	137.5	31.8	2
pH	7.6	0.0	1	7.5	0.0	1	7.6	0.07	2
Total Alkalinity, mg/l	164.0	0.0	1	201.0	0.0	1	182.5	26 [illegible]	2
Physicochemical (Bottom):									
Dissolved Oxygen (DO), mg/l	-	-	-	-	-	-	-	-	-
Temperature, °C	-	-	-	-	-	-	-	-	-
Turbidity, JTU	-	-	-	-	-	-	-	-	-
pH	-	-	-	-	-	-	-	-	-
Total Alkalinity, mg/l	-	-	-	-	-	-	-	-	-
Physical Measurements:									
Current Velocity, fps	2.4	0.0	1	0.08	0.0	1	1.3	1.7	2
Settleable Solids, ml/l	0.1	0.0	1	0.1	0.0	1	0.1	0.0	2
Secchi Disk, cm	-	-	-	22.0	0.0	1	22.0	0.0	1
Depth, m	5.6	0.0	1	0.5	0.0	1	3.05	3.6	2

Note: $\bar{X}$ = mean value
SD = standard deviation
No. obs = number of observations
\- indicates no sample taken

AD-A116 667 ARMY ENGINEER DISTRICT ST LOUIS MO F/6 13/2
OPERATION AND MAINTENANCE POOLS 24, 25, AND 26 MISSISSIPPI AND --ETC(U)
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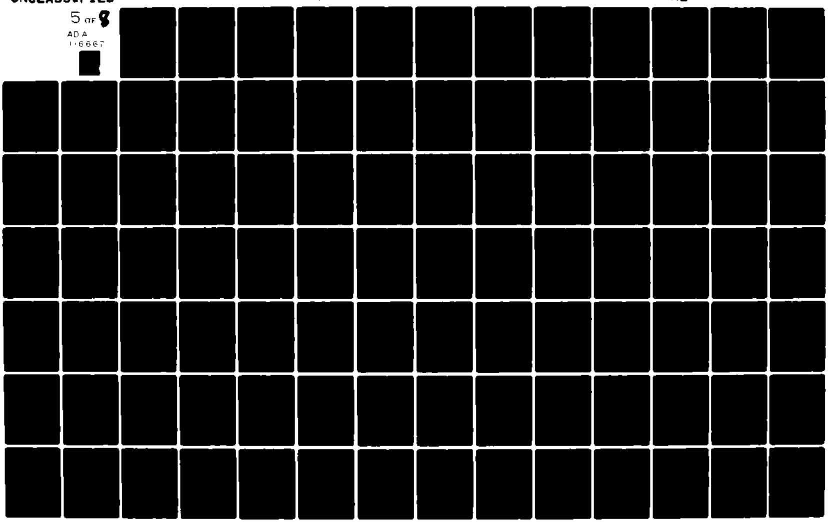

Table 8.

Statistical Analysis of Physical and Chemical Data from River Border Areas, Lower Illinois River, 1974.

Variable	July 1974 $\bar{X}$	July 1974 SD	July 1974 No. Obs	September 1974 $\bar{X}$	September 1974 SD	September 1974 No. Obs	Over Periods $\bar{X}$	Over Periods SD	N
Physiochemical (Surface):									
Dissolved Oxygen (DO), mg/l	5.7	0.4	11	8.9	0.8	11	7.2	1.8	22
Temperature, °C	26.5	1.1	11	23.3	2.3	11	24.9	2.4	22
Turbidity, JTU	147.3	41.7	11	100.9	25.0	11	124.1	41.1	22
pH	7.5	0.3	11	7.8	0.3	11	7.6	0.3	22
Total Alkalinity, mg/l	149.1	19.7	11	196.3	6.8	10	171.6	28.3	21
Physiochemical (Bottom):									
Dissolved Oxygen (DO), mg/l	6.0	0.8	3	8.9	0.5	3	7.5	1.7	6
Temperature, °C	25.3	0.6	3	22.3	0.6	3	23.8	1.7	6
Turbidity, JTU	204.0	46.9	3	95.0	13.2	3	149.5	67.2	6
pH	7.5	0.06	3	8.1	0.2	3	7.8	0.3	6
Total Alkalinity, mg/l	132.0	26.9	3	202.0	6.9	3	167.0	42.2	6
Physical Measurements:									
Current Velocity, fps	1.9	0.5	11	0.4	0.3	11	1.2	0.9	22
Settleable Solids, ml/l	0.1	0.1	10	0.1	0.04	11	0.1	0.06	21
Secchi Disk, cm	-	-	-	20.9	4.4	11	20.9	4.4	11
Depth, m	6.3	1.8	11	1.4	1.8	11	3.8	3.1	22

Note: $\bar{X}$ = mean value
SD = standard deviation
No. Obs = number of observations
\- indicates no sample taken

Table 9. Results of Chemical Analysis of Hydraulic Dredge Effluent from the Upper Mississippi and Lower Illinois Rivers in the St. Louis District.

River Mile	Date	Volatile Solids	Chemical Oxygen Demands	Total Kjeldahl Nitrogen	Oil and Grease	Mercury	Lead	Zinc
Illinois River								
38.7	17 May 1972	2.18	1.18	0.042	0.040	0.00008	0.0008	0.0044
41.5	11 May 1972	1.65	0.78	0.025	0.043	0.00001	0.0019	0.0022
43.9	28 Apr 1972	3.12	2.88	0.043	0.008	0.00002	0.0011	0.0048
55.5	17 May 1972	2.85	1.77	0.070	0.106	0.00006	0.0005	0.0040
76.0	28 Apr 1972	2.02	1.96	0.041	0.015	0.00001	0.0010	0.0027
Mississippi River								
223.3	13 May 1972	0.80	0.57	0.022	0.050	0.00002	0.0001	0.0042
226.5	8 June 1972	0.89	0.72	0.024	0.003	0.00001	0.0008	0.0018
235.0	10 June 1972	0.32	0.16	0.005	0.009	0.00001	0.0005	0.0022
257.0	10 June 1972	1.14	0.14	0.011	0.048	0.00001	0.0005	0.0022
290.6	21 June 1972	0.17	0.21	0.008	0.002	0.00001	0.0007	0.0013
298.2	21 June 1972	0.24	0.19	0.009	0.017	0.00001	0.0006	0.0015
Dredge Material Disposal Criteria*		6.0	5.0	0.10	0.15	0.0001	0.005	0.005

*Cited in Boyd et al., 1972

Table 10

CHARACTER OF MATERIALS DREDGED
ILLINOIS WATERWAY
MILES 0.0 - 80.0
GRAFTON TO LAGRANGE, ILLINOIS

Mile	Location	Gravel	Course Sand	Silt Sand	Mud	Debris	Shells	Rock
25.5	H. Diamond Island		5	40	20	10	30	
28.5	Crater Field	2	12	40	20	10	16	
30.0	Willow Island			20	20	10	10	40
31.4	Old Kampsville Lock					10	10	80
33.5	Silver Creek			35	40	15	20	
34.2	Above Silver Creek			35	40	10	15	
35.7	Apple Creek Lower			40	20	20	20	
38.0	Twin Islands	5		50	10	15	20	
40.5	Spar Island			50	10	15	20	
41.5	Pearl Island			50	10	15	20	
42.5	Hardy Creek			50	10	15	20	
44.0	Van Geson Lower			50	10	15	20	
45.0	Van Geson			50	10	15	20	
46.0	Buckhorn Island			50	10	15	20	
47.0	Hillview Landing			40	20	15	20	
48.0	Pilot Peak Landing			40	20	15	20	
49.0	Bedford			40	20	15	20	
50.3	Little Sandy Creek			40	20	15	20	
53.0	Needsome Creek		20	40		15	25	
55.5	Florence, Ill.		20	40		15	25	
58.0	Big Blue Creek		10	40	10	15	25	
60.5	Griggsville Landing		5	45	10	15	25	
62.5	Mauvais Terre		5	45	10	15	25	
63.5	Mauvais Terre Creek		5	45	10	15	25	
65.0	Naples, Ill.		5	45	10	15	25	
66.0	McGees Creek		5	45	10	15	25	
[illegible]	Meredosia Island		5	45	10	15	25	
7[illegible].0	Meredosia, Ill.		5	45	10	15	25	
72.0	Above Meredosia Bridge		10	45	10	20	15	
73.0	Wilson Island		5	45	10	25	15	
75.0	Kamp Creek			60	20	10	10	
77.0	Moores Landing			60	20	10	10	
79.0	Indian Creek		5	55	20	10	10	

Table 11

CHARACTER OF MATERIALS DREDGED
UPPER MISSISSIPPI RIVER

Mile	Location	Gravel	Course Sand	Clay	Silt Sand	Mud	Debris	Gumbo	Shel
208	Piasa Island Lower	1	15		65	5	14		
219	Squaw Island	1	40		40	4	15		
221	Hd. Island 521	2	40		40	3	15		
224	Hd. Enterprise Island	2	40		45	3	10		
226	Milan Landing	2	40		45	3	10		
228	Hd. Dardenne Chute	2	45		40	3	10		
230	Fruitland (Golden Eagle Ferry)	2	40		40	8	10		
232	Two Branch Island	2	40		40	8	10		
234	Sweden Island	2	40		40	8	10		
236	Martin Towhead	2	40		40	8	10		
238	Head Turkey Island	2	40		40	8	10		
243	Wilson Island	2	40		40	8	10		
245	Turner Island	2	40		40	8	10		
247	Jim Crow Island	2	40		40	8	10		
249	Stag Island	2	40		40	8	10		
251	Sterling Island	2	40		40	8	10		
253	Head Sterling Island	2	40		40	8	10		
255	Reds Landing	2	40		40	8	10		
257	Kelly Island	2	40		40	8	10		
263	Tisdale Island	2	30		40		15	13	
265	Coon Island Lower	2	30		35	8	15	10	
267	Head Slim Island	2	30		35	8	15	10	
269	Amaranth Island	2	30		35	8	15	10	
273	Clarksville	2	30		35	8	15	10	
277	Pharrs Island		30		55	5	10		
281	Buffalo Island	2	30		60		8		
287	Fritz Island	2	40		40	8	10		
289	Copperfield		40		50		10		
292	Atlas Island		40		50		10		
296	Cincinnati Landing	2	40		50		8		
298	Tom Taylor	2	40		50		8		

APPENDIX C

BIOLOGICAL

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FIGURES

TABLE 1.

SURFACE AREAS AND ASSOCIATED PERCENTAGES CALCULATED FOR HABITAT TYPES IN POOLS 24, 25, AND 26, UPPER MISSISSIPPI RIVER; AND 80 MILES OF THE LOWER ILLINOIS RIVER

	HABITAT TYPE								
MISSISSIPPI RIVER	MAIN CHANNEL		SIDE CHANNEL		DIKE		RIVER BORDER		TOTAL
	AREA*	%	AREA	%	AREA	%	AREA	%	AREA
POOL 24	1.63	8.9	6.38	34.8	2.72	14.8	7.60	41.5	18.33
POOL 25	1.83	8.0	7.38	32.2	3.76	4.4	9.93	43.4	22.90
POOL 26	2.17	8.5	5.93	23.3	6.24	24.5	11.10	43.6	25.44
COMBINED	5.63	8.4	19.69	29.5	12.72	19.1	28.63	42.9	66.67
ILLINOIS RIVER	4.51	29.9	1.40	9.3	0.32	2.1	8.87	58.7	15.10

*Area values are expressed as square miles.

Table 2.

Composite List of Phytoplankton Species Collected from the Mississippi and Illinois Rivers During July and September 1974

Taxa	Mississippi River		Illinois River	
	Side Channel	Main Channel	Side Channel	Main Channel
CHLOROPHYTA				
Actinastrum gracilimum G. M. Smith	x	x		x
A. hantzschii Lagerheim	x			
cf. Binuclearia sp. Wittrock	x	x		x
Chlorella sp. Beyerinck	x	x	x	
Closterium acerosum (Schrank) Ehrenberg		x		
C. acutum (Lyngbye) Brébisson	x	x		
Closterium sp. Nitzsch				x
Coelastrum microporum Naegeli	x	x		
C. reticulatum (Daneard) Senn	x			
C. sphaericum Naegeli	x			
Crucigenia rectangularis (A. Br.) Gay			x	x
C. tetrapedia (Kirch.) W. & G. S. West	x		x	
Dictyosphaerium pulchellum Wood		x	x	
Dimorphococcus lunatus A. Braun		x		
Franceia ovalis (Francé) Lemmermann	x	x		
Gloeocystis gigas (Kuetzing) Lagerheim	x			
Golenkinia radiata (Chodat) Wille		x		x
Lagerheimia quadriseta (Lemm.) G. M. Smith	x			
Micractinium pusillum Fresenius	x	x	x	x
Monoraphidium contortum (Thuret in Brébisson)	x	x		x
Monoraphidium sp. Komárková-Legnerová			x	x
Oocystis borgei Snow	x			
O. lacustris Chodat		x		
O. pusilla Hansgirg	x	x		x
Oocystis sp. Naegeli		x	x	x
Pediastrum boryanum (Turp.) Meneghini	x	x	x	x
P. duplex Meyen	x	x	x	x
P. simplex (Meyen) Lemmermann		x		
Scenedesmus abundans (Kirch.) Chodat	x			
S. acuminatus (Lagerheim) Chodat				x
S. armatus (Chodat) G. M. Smith	x	x		

Sheet 1 of 7

Table 2.

Composite List of Phytoplankton Species Collected from the Mississippi and Illinois Rivers During July and September 1974

Taxa	Mississippi River		Illinois River	
	Side Channel	Main Channel	Side Channel	Main Channel
CHLOROPHYTA (continued)				
S. bijuga (Turp.) Lagerheim			x	
S. bijuga var. alternans (Reinsch) Hansgirg		x		
S. brasiliensis Bohlin			x	
S. carinatus (Lemm.) Chodat	x			
S. denticulatus Lagerheim	x		x	x
S. dimorphus (Turp.) Kuetzing	x	x	x	x
S. opoliensis P. Richter	x	x	x	x
S. quadricauda (Turp.) Brébisson	x	x	x	x
S. quadricauda var. alternans G. M. Smith				x
Schroederia setigera (Schroeder) Lemmermann			x	
Sphaerocystis schroeteri Chodat	x			
Tetraëdron minimum (A. Br.) Hansgirg	x	x		x
T. muticum (A. Braun) Hansgirg		x		
T. muticum var. punctulatum (Reinsch)	x			
T. regulare Kuetzing	x	x		
T. trigonum (Naegeli) Hansgirg	x	x		
Tetrastrum glabrum (Roll.) Ahlstrom & Tiffany	x	x	x	
T. heteracanthum (Nordst.) Chodat	x		x	
A. staurogeniaeforme (Schroeder) Lemmermann		x		x
Tetrastrum sp. Chodat	x	x		
Treubaria crassispina G. M. Smith			x	
CHRYSOPHYTA				
Centrales				
Coscinodiscus denarius			x	x
C. lacustris Grunow	x	x	x	x
C. rothii (E.) Grunow	x	x	x	x
Coscinodiscus sp. Ehrenberg	x	x		
Cyclotella atomus Hustedt	x	x	x	x
C. bodanica Eulenst.			x	
C. kuetzingiana Thwaites		x		x

Sheet 2 of 7

Table 2.

Composite List of Phytoplankton Species Collected from the Mississippi and Illinois Rivers During July and September 1974

Taxa	Mississippi River		Illinois River	
	Side Channel	Main Channel	Side Channel	Main Channel
CHRYSOPHYTA (continued)				
Centrales (continued)				
C. meneghiniana Kuetzing	x	x	x	x
C. michiganiana Skvortzow	x	x	x	x
C. ocellata Pantocsek	x			x
Cyclotella cf. ocellata Pantocsek			x	x
C. operculata (Agardh) Kuetzing	x	x		x
C. pseudostelligera Hustedt		x		x
C. stelligera Cleve & Grunow	x	x		x
C. striata (Kuetzing) Grunow	x	x	x	x
Cyclotella spp. Kuetzing	x	x	x	x
Melosira ambigua (Grunow) O. Müller	x	x		x
M. distans (Ehrenberg) Kuetzing	x	x	x	x
M. granulata (Ehrenberg) Ralfs	x	x	x	x
M. granulata var. angustissima Müller	x	x	x	x
M. italica (Ehrenberg) Kuetzing	x	x	x	x
M. varians Agardh	x	x		x
Melosira sp. Agardh	x	x		
Stephanodiscus astrea (Ehrenberg) Grunow	x	x		x
S. astrea var. Minutula (Kuetzing) Grunow	x	x		
S. hantzschii Grunow	x	x	x	x
S. invisitatus	x	x		x
S. niagarae Ehrenberg	x	x		x
S. tenuis Hustedt	x	x		x
Stephanodiscus sp. Ehrenberg			x	
Unidentified centrics	x	x		
Pennales				
Achnanthes cf. brevipes Agardh	x			
A. lanceolata var. haynaldii (Istv.-Schaarschl) Cl.		x		
A. minutissima (Kuetzing) Cleve	x			
Achnanthes sp. Bory	x	x		

Sheet 3 of 7

Table 2.

Composite List of Phytoplankton Species Collected from the Mississippi and Illinois Rivers During July and September 1974

Taxa	Mississippi River Side Channel	Mississippi River Main Channel	Illinois River Side Channel	Illinois River Main Channel
CHRYSOPHYTA (continued)				
Pennales (continued)				
cf. Amphora normani Rabenhorst				x
Amphora sp. Ehrenberg	x	x		
Asterionella formosa Hass.	x	x		
A. formosa var. gracillima (Hantz.) Grunow	x	x		
Cocconeis pediculus Ehrenberg			x	
C. placentula var. euglypta (Ehrenberg) Cl.	x	x		
C. scutellum (Ehrenberg)	x			
Cymatopleura solea (Brébisson) W. Smith	x	x		
Cymbella sp. Agardh	x	x		x
Diploneis cf. elliptica (Kuetzing)				x
Diploneis sp. Ehrenberg			x	x
Fragilaria brevistriata Grunow	x	x	x	x
F. capucina Desmazieres	x	x		
F. crotonensis Kitton	x	x		
F. nitzschioides Grunow	x			
F. vaucheriae var. vaucheriae (Kuetzing)	x			
Fragilaria spp. Lyngb.	x	x		x
Gomphonema olivaceum (Lyngbye) Keutzing		x		
Gomphonema sp. Agardh		x		
Gyronigma scalproides (Rabh.)	x	x		
G. spencerii (Quek.)	x	x	x	x
Hantzschia amphioxys (Ehrenberg) Grunow	x	x	x	
Meridion circulare (Greville) Agardh	x	x		
Navicula confervacea var. peregrina (W. Smith)Grunow		x		
N. exigua Greg. ex Grunow		x		
N. gregaria Donk.		x		
N. inflexa				x
N. lanceolata Kuetzing	x	x	x	x
N. luzonensis Hustedt		x		

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Table 2.

Composite List of Phytoplankton Species Collected from the Mississippi and Illinois Rivers During July and September 1974

Taxa	Mississippi River		Illinois River	
	Side Channel	Main Channel	Side Channel	Main Chann
CHRYSOPHYTA (continued)				
Pennales (continued)				
N. minima Grunow	x			
N. muralis Grunow	x			
N. mutica Kuetzing	x	x		x
N. notha Wallace	x			
N. pelliculosa (Bréb. *ex* Kuetz.) Hilse	x			
N. pupula Kuetzing	x	x	x	x
N. secura Patrick	x	x		x
N. tripunctata (O. F. Müller) Bory	x			
Navicula spp. Bory	x	x	x	x
Nitzschia acicularis (Kuetzing) W. Smith	x	x	x	x
N. apiculata		x		
N. commutata Grunow		x		
N. dissipata Grunow	x	x	x	x
Nitzschia cf. *gracilis* Hantzsch.	x			
N. palea (Kuetzing) W. Smith	x	x	x	x
N. palea var. *tenuirostris* Grunow				x
N. paradoxa (Gmel.)	x	x		x
N. sigmoidea (Nitzsch) W. Smith	x			
N. tryblionella (Hantzsch.)	x	x		x
Nitzschia spp. Hassall	x	x	x	x
Pinnularia obscura Krasske		x		
Pinnularia sp.		x		
Rhoicosphenia curvata (Kuetzing) Grunow *ex* Rabenhorst	x			
Stauroneis Ehrenberg	x			
Surirella angustata Kuetzing			x	
S. minuta Brébisson	x	x		x
cf. *S. ovalis* Brébisson		x		
S. ovata Kuetzing		x		x
Surirella sp. Turpin	x	x		
Synedra acus Kuetzing	x			x

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Table 2.

Composite List of Phytoplankton Species Collected from the Mississippi and Illinois Rivers During July and September 1974

Taxa	Mississippi River Side Channel	Mississippi River Main Channel	Illinois River Side Channel	Illinois River Main Channel
CHLOROPHYTA (continued)				
Pennales (continued)				
S. amphicephala var. austriaca (Grunow) Hustedt		x		
S. delicatissima W. Smith	x	x	x	
S. delicatissima var. angustissima Grunow		x		
S. fasciculata (Agardh) Kuetzing			x	x
S. fasciculata var. truncata (Grev.) Patrick		x		
S. filiformis var. exilis Cleve-Euler				x
S. nana Meist.		x		
S. rumpens Kuetzing	x	x		
S. ulna (Nitz.) Ehrenberg	x	x		
S. ulna var. chaseana Thomas	x	x		x
S. ulna var. contracta Østr.		x		
S. ulna var. longissima (W. Smith) Brun.	x	x		
Synedra sp. Ehrenberg	x	x		x
Tabellaria flocculosa (Roth) Kuetzing		x		x
Chrysomonadales				
Dinobryon sociale Ehrenberg	x			
Ophiocytium capitatum Wolle	x			
CYANOPHYTA				
Agmenellum quadruplicatum Brébisson			x	
Anabaena unispora Gardner	x	x		
Anabaena sp. Bory	x	x		
Anacystis cyanea Drouet & Dailey	x	x	x	x
A. marina Drouet & Dailey	x	x	x	x
A. thermalis (Menegh.) Drouet & Dailey	x	x	x	x
Anacystis sp. Meneghini		x		
Coccochloris peniocystis (Kuetzing) Drouet & Dailey	x	x		
Coccochloris sp. Sprengel	x	x		
Marssoniella elegans		x		
Oscillatoria anguina (Bory) Gomont			x	

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Table 2.

Composite List of Phytoplankton Species Collected from the Mississippi and Illinois Rivers During July and September 1974

Taxa	Mississippi River Side Channel	Mississippi River Main Channel	Illinois River Side Channel	Illinois River Main Channel
CYANOPHYTA (continued)				
Oscillatoria sp. Vaucher	x	x		x
EUGLENOPHYTA-PYRROPHYTA				
Euglena acus Ehrenberg	x	x	x	x
Euglena sp. Ehrenberg	x	x	x	x
Ceratium hirundinella (O. F. Müller) Dujardin	x			
Glenodinium penardiforme (Linde.) Schiller	x			
Phacus acuminatus Stokes	x	x	x	x
P. acuminatus var. drezepolskii Skvortzow			x	
P. longicauda (Ehrenberg) Dujardin		x		
P. triqueter (Ehrenberg) Dujardin	x			
Phacus sp. Dujardin	x			
Trachelomonas crebea (Kellicott) Deflandre	x	x		x
T. dubia (Swir.) Deflandre	x			
T. granulosa Playfair		x		
T. pulchella Drezepolski		x		
T. schauinslandii Lemmermann	x	x	x	x
T. similis Stokes	x	x	x	
T. volvocina Ehrenberg	x			x
Trachelomonas sp. Ehrenberg	x	x	x	

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Table 3.
Statistical Analysis of Biological Data from Side Channel; Pools 24, 25, and 26, Mississippi River; 1974

Variable	July 1974 $\bar{X}$	July 1974 SD	July 1974 No. Obs	September 1974 $\bar{X}$	September 1974 SD	September 1974 No. Obs	Over Periods $\bar{X}$	Over Periods SD	Over Periods No. Obs
Phytoplankton (no./ℓ):									
Chlorophyta	153.6	199.2	12	623.8	493.9	12	388.7	[illegible]	[illegible]
Chrysophyta	2578.3	6692.6	12	5056.6	3081.6	12	3817.4	[illegible]	[illegible]
Cyanophyta	29.2	73.3	12	807.9	651.1	12	418.5	[illegible]	24
Euglenophyta	81.2	205.5	12	178.8	285.5	12	130.0	244.4	24
Total Density	2842.3	7213.7	12	6667.1	3590.4	12	4754.7	5782.2	24
Species Diversity, $\bar{d}$	3.10	0.86	12	3.80	0.38	12	3.45	0.74	24
Evenness Index, e	0.82	0.14	12	0.77	0.06	12	0.80	0.11	24
Zooplankton (no./ℓ):									
Cladocera	0.7	1.0	12	2.3	2.3	12	1.5	1.9	24
Copepoda	3.3	4.3	12	14.6	9.7	12	9.0	9.4	24
Rotifera	4.5	10.0	12	36.8	39.0	12	20.6	32.3	24
Total Density	8.5	14.8	12	53.7	37.6	12	31.1	36.2	24
Species Diversity, $\bar{d}$	1.42	1.32	12	3.03	0.47	12	2.22	1.27	24
Evenness Index, e	0.94	0.06	7	0.83	0.12	12	0.87	0.11	19
Benthos (no./m^2):									
Oligochaeta	321.9	647.6	12	476.9	507.4	12	399.4	574.4	24
Hirudinea	0.0	0.0	12	0.9	3.2	12	0.5	2.3	24
Pelecypoda	29.1	83.2	12	19.5	57.4	12	24.3	70.0	24
Gastropoda	0.0	0.0	12	1.8	6.4	12	0.9	4.5	24
Crustacea	0.4	1.4	12	0.0	0.0	12	0.2	[illegible]	24
Turbellaria	0.0	0.0	12	0.0	0.0	12	0.0	0.0	24
Nematoda	1.8	6.4	12	0.0	0.0	12	0.9	4.5	24
Insecta	505.3	953.2	12	544.9	374.0	12	525.1	708.5	24
Total Density	858.5	1389.6	12	1044.1	697.3	12	951.3	1079.4	24
Species Diversity, $\bar{d}$	2.26	1.10	12	2.60	0.68	12	2.43	0.91	24
Evenness Index, e	0.73	0.28	12	0.80	0.08	12	0.76	0.20	24
Number of Taxa	8.1	5.9	12	11.4	2.7	12	9.8	4.8	24

NOTE: $\bar{X}$ = mean value
SD = standard deviation
No. obs = number of observations
\- indicates no sample taken

Table 4.

Statistical Analysis of Biological Data from Main Channel; Pools 24, 25, and 26, Mississippi River; 1974

Variable	July 1974			September 1974			Over Periods		
	$\bar{X}$	SD	No. Obs	$\bar{X}$	SD	No. Obs	$\bar{X}$	SD	No. Obs
Phytoplankton (no./ℓ):									
Chlorophyta	50.5	57.9	13	40621.4	5765.5	13	20336.0	4137.0	26
Chrysophyta	366.7	213.1	13	7209.2	8264.2	13	3773.0	6706.5	26
Cyanophyta	15.7	32.6	13	644.8	607.8	13	330.0	536.4	26
Euglenophyta	30.1	37.5	13	36.0	53.9	13	33.0	45.6	26
Total Density	433.0	217.[illegible]	13	48511.5	143738.3	13	24477.3	104550.1	26
Species Diversity, $\bar{d}$	3.24	0.64	13	3.31	1.12	13	3.27	0.89	26
Evenness Index, e	0.88	0.07	13	0.70	0.24	13	0.79	0.19	26
Zooplankton (no./ℓ):									
Cladocera	0.2	0.4	13	2.2	1.9	13	1.2	1.7	26
Copepoda	1.5	2.1	13	10.3	9.5	13	5.9	8.1	26
Rotifera	0.7	1.0	13	15.5	13.1	13	8.1	11.8	26
Total Density	2.5	3.3	13	28.0	20.6	13	15.2	19.5	26
Species Diversity, $\bar{d}$	0.68	0.99	13	2.62	1.23	13	1.65	1.[illegible]	26
Evenness Index, e	0.97	0.06	5	0.87	0.06	11	0.90	0.08	16
Benthos (no./m^2):									
Oligochaeta	23.0	81.7	13	5.2	14.2	13	14.1	58.2	26
Hirudinea	0.0	0.0	12	0.0	0.0	13	0.0	0.0	25
Pelecypoda	0.3	1.1	13	1.2	2.2	13	0.7	1.8	26
Gastropoda	0.3	1.1	13	0.0	0.0	13	0.2	0.8	26
Crustacea	0.0	0.0	13	0.0	0.0	13	0.0	0.0	26
Turbellaria	0.0	0.0	13	0.0	0.0	13	0.0	0.0	26
Nematoda	0.0	0.0	13	0.0	0.0	13	0.0	0.0	26
Insecta	29.3	38.0	13	250.5	285.8	13	139.9	229.4	26
Total Density	52.9	87.4	13	256.9	298.1	13	154.8	239.0	26
Species Diversity, $\bar{d}$	1.11	0.96	13	1.50	0.72	13	1.31	0.85	26
Evenness Index, e	0.63	0.45	13	0.61	0.36	13	0.63	0.36	26
Number of Taxa	3.0	2.7	13	5.8	[illegible]	13	4.4	3.3	26

NOTE: $\bar{X}$ = mean value
SD = standard deviation
No. obs = number of observations
- indicates no sample taken

Table 5.
Statistical Analysis of Biological Data from Main Channel, Lower Illinois River, 1974

Variable	[illegible] $\bar{X}$	SD	No. Obs	September at [illegible] $\bar{X}$	SD	No. Obs	Over Periods $\bar{X}$	SD	No. Obs
Phytoplankton (no./l):									
Chlorophyta	101.6	157.7	6	535.8	277.1	6	318.5	312.4	12
Chrysophyta	302.2	115.9	6	2102.7	909.5	6	1204.4	1123.7	12
Cyanophyta	0.0	0.0	6	138.2	145.7	6	69.1	121.9	12
Euglenophyta	3.7	21.2	6	57.2	48.2	6	30.9	43.4	12
Total Density	416.7	238.6	6	2833.8	1290.1	6	1625.3	1539.4	12
Species Diversity, $\bar{d}$	2.30	0.23	6	4.09	0.54	6	3.3[illegible]	0.73	12
Evenness Index, e	0.69	0.06	6	0.88	0.02	6	0.86	0.04	12
Zooplankton (no./l):									
Cladocera	1.3	1.2	6	1.5	1.5	6	1.5	1.3	12
Copepoda	10.5	9.3	6	20.5	11.6	6	15.5	11.0	12
Rotifera	1.3	1.9	6	21.0	13.2	6	11.2	13.6	12
Total Density	13.2	10.5	6	43.0	5.6	6	30.6	21.7	12
Species Diversity, $\bar{d}$	1.56	0.99	6	2.24	1.13	6	2.05	1.03	12
Evenness Index, e	0.86	0.07	6	0.78	0.02	6	0.82	0.07	12
Benthos (no./m^2):									
Oligochaeta	0.7	1.6	6	37.0	53.6	6	18.8	40.8	12
Hirudinea	0.0	0.0	6	0.0	0.0	6	0.0	0.0	12
Pelecypoda	9.2	12.9	6	13.3	20.2	6	11.3	16.2	12
Gastropoda	0.0	0.0	6	0.0	0.0	6	0.0	0.0	12
Crustacea	0.0	0.0	6	0.0	0.0	6	0.0	0.0	12
Turbellaria	0.0	0.0	6	0.0	0.0	6	0.0	0.0	12
Nematoda	0.0	0.0	6	0.0	0.0	6	0.0	0.0	12
Insecta	16.0	11.9	6	95.2	111.5	6	55.6	86.2	12
Total Density	25.8	18.8	6	145.5	126.3	6	85.7	106.7	12
Species Diversity, $\bar{d}$	0.91	0.51	6	1.52	0.95	6	1.22	0.80	12
Evenness Index, e	0.82	0.40	6	0.61	0.33	6	0.71	0.37	12
Number of Taxa	2.0	1.6	6	5.2	2.9	6	3.6	[illegible]	12

NOTE: $\bar{X}$ = mean value
SD = standard deviation
No. obs = number of observations
\- indicates no sample taken

Table 6.
Statistical Analysis of Biological Data from
Side Channels, Lower Illinois River, 1974

Variable	July 1974 $\bar{X}$	July 1974 SD	No. Obs	September 1974 $\bar{X}$	September 1974 SD	No. Obs	Over Periods $\bar{X}$	Over Periods SD	No. Obs
Phytoplankton (no./L):									
[illegible]	32.2	56.[illegible]	3	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Chrysophyta	448.0	256.0	3	2834.0	737.[illegible]	3	1641.0	[illegible]	6
Cyanophyta	0.0	0.0	3	143.0	225.4	3	71.5	151.5	6
[illegible]	116.0	122.4	3	84.3	53.6	3	100.2	89.3	6
Total Density	596.3	215.3	3	3777.7	780.6	3	2187.0	[illegible]	[illegible]
Species Diversity, $\bar{d}$	2.93	0.74	3	4.13	0.56	3	[illegible]	[illegible]	[illegible]
Evenness Index, e	0.90	0.04	3	0.37	0.09	3	[illegible]	[illegible]	[illegible]
Zooplankton (no./L):									
Cladocera	0.7	0.6	3	2.7	2.1	3	1.7	1.8	6
Copepoda	6.0	2.6	3	15.3	10.7	3	10.7	8.5	6
Rotifera	2.3	1.5	3	16.0	2.5	3	9.2	[illegible]	6
Total Density	9.0	2.0	3	34.0	10.5	3	21.5	15.3	6
Species Diversity, $\bar{d}$	2.31	0.57	3	2.82	0.17	3	2.56	[illegible]	6
Evenness Index, e	0.9	0.07	3	0.84	0.02	3	0.87	0.06	6
Benthos (no./m^2):									
Oligochaeta	717.3	426.[illegible]	3	218.7	72.2	3	468.0	386.[illegible]	6
Hirudinea	0.0	0.0	3	0.0	0.0	3	0.0	0.0	6
Pelecypoda	115.3	100.1	3	14.7	25.4	3	65.0	85.5	6
Gastropoda	0.0	0.0	3	0.0	0.0	3	0.0	0.0	6
Crustacea	0.0	0.0	3	0.0	0.0	3	0.0	0.0	6
Turbellaria	0.0	0.0	3	0.0	0.0	3	0.0	0.0	6
Nematoda	0.0	0.0	3	0.0	0.0	3	0.0	0.0	6
Insecta	215.0	324.8	3	214.3	211.2	3	214.7	245.0	6
Total Density	1047.7	593.2	3	447.7	308.5	3	747.7	537.5	6
Species Diversity, $\bar{d}$	2.72	0.21	3	3.03	0.32	3	2.87	0.30	6
Evenness Index, e	0.81	0.03	3	0.87	0.06	3	0.84	0.06	6
Number of Taxa	10.7	2.9	3	11.3	3.1	3	11.0	2.7	6

NOTE: $\bar{X}$ = mean value
SD = standard deviation
No. obs = number of observation
\- indicates no sample taken

Table 7.

Composite List of Zooplankton Species Collected from the Mississippi and Illinois Rivers During July and September 1974

Taxa	Mississippi River		Illinois River	
	Side Channel	Main Channel	Side Channel	Main Channel
[illegible]				
[illegible]	x	x	x	x
[illegible] spp. Dana	x	x		x
Chydorus spp. Leach	x			
Daphnia [illegible]	x	x	x	x
D. retrocurva Forbes	x			x
Leptodora kindtii (Focke)	x			
Moina micrura Kurz	x	x	x	x
COPEPODA				
Calanoid copepodids	x	x	x	x
Cyclopoid copepodids	x	x	x	x
Cyclops vernalis Fischer	x	x	x	x
Diaptomus siciloides Lilljeborg	x	x	x	x
Nauplii	x	x	x	x
ROTIFERA				
Brachionus angularis Gosse	x	x	x	x
B. budapestinensis Daday	x	x	x	x
B. calyciflorus Pallas	x	x	x	x
B. caudatus Barrois & Daday	x	x	x	x
B. [illegible] Hermann	x	x		
[illegible] spp. [illegible]	x			x
[illegible] spp. Harring	x	x		x
Conochiloides spp. Hlava	x	x		
Kellicottia bostoniensis (Rousselet)	x			
Keratella cochlearis (Gosse)	x	x	x	x
[illegible] spp. Ehrenberg	x	x	x	x
[illegible] spp. Ehrenberg	x	x	x	
[illegible] spp. Ehrenberg	x	x		x
[illegible] spp. Lamarck	x	x		x
[illegible] spp. Bory de St. Vincent				

TABLE 8

Composite List of Benthic Organisms Collected from the Mississippi and Illinois Rivers During July and September 1974

Taxa	Mississippi River: Main Channel	Mississippi River: River Border Area	Mississippi River: Dike	Mississippi River: Side Channel	Illinois River: Main Channel	Illinois River: River Border Area	Illinois River: Dike	Illinois River: Side Channel
NEMATODA		X		X				
PLATYHELMINTHES								
Turbellaria						X		
Planariidae								
<u>Dugesia</u> sp. Girard		X	X					
ANNELIDA								
Hirudinea								
Glossiphoniidae								
<u>Glossiphonia</u> <u>complanata</u> (Linnaeus)						X		
<u>G.</u> <u>heteroclita</u> (Linnaeus)						X		
<u>Placobdella</u> <u>ornata</u> (Verrill)		X						
<u>P.</u> <u>parasitica</u> (Say)		X		X				
Oligochaeta								
Lumbriculidae								
<u>Lumbriculus</u> <u>variegatus</u> (Müller)	X	X	X	X				
Naididae								
<u>Dero</u> <u>digitata</u> (Müller)		X	X	X				
<u>Nais</u> <u>barbata</u> (Müller)			X					
<u>N.</u> <u>communis</u> Piguet	X	X	X	X	X	X		
<u>N.</u> <u>simplex</u> Piguet	X	X	X	X		X		X
<u>Nais</u> spp. (Müller)		X		X			X	
<u>Pristina</u> <u>breviseta</u> Bourne		X	X					
<u>P.</u> <u>plumaseta</u> Turner		X						
<u>Pristina</u> spp. Ehrenberg			X					
<u>Slavina</u> <u>appendiculata</u> d'Udekem	X			X				
Tubificidae								
<u>Branchiura</u> <u>sowerbyi</u> Beddard	X	X		X	X	X	X	X
<u>Ilyodrilus</u> <u>templetoni</u> (Southern)						X		X
<u>Limnodrilus</u> <u>angustipenis</u> Brinkhurst & Cook				X				
<u>L.</u> <u>cervix</u> Brinkhurst			X	X	X	X	X	X

TABLE 3 (Continued)

Taxa	Mississippi River [illegible]							
	Main	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Tubificidae (continued)								
L. claparedeianus Ratzel		X	X	X	X	X		
L. hoffmeisteri Claparède	X	X	X	X	X	X	X	X
L. maumeensis Brinkhurst & Cook		X	X	X		X		X
L. profundicola (Verrill)	X	X		X				X
L. spiralis (Eisen) Vejdovsky				X	X	X	X	
L. udekemianus Claparède	X	X	X	X	X	X		X
Limnodrilus spp. Claparède	X	X	X	X	X	X		X
Peloscolex ferox (Eisen)	X	X	X	X	X	X		X
P. freyi Brinkhurst				X				
P. multisetosus (Smith)			X			X		
P. variegatus Leidy		X	X					
Potamothrix vejdovskyi Rab				X		X		
Psammoryctides curvisetosus Brinkhurst & Cook			X	X		X		
Rhyacodrilus coccineus (Vejdovsky)			X			X		
Tubifex ignotus (Stolc)		X		X		X		X
T. tubifex (Müller)	X		X	X	X	X		X
MOLLUSCA								
Amblemidae								
Amblema plicata (Say)		X				X		
Fusconaia ebena (Lea)			X					
Megalonaias giganteus (Barnes)		X						
Quadrula nodulata (Say)		X	X					
Q. pustulosa (Lea)								
Q. quadrula (Rafinesque)		X						
Corbiculidae								
Corbicula manilensis (Philippi)	X							
Physidae								
Physa sp. Draparnaud	X							

TABLE 3 (Continued)

Taxa								
MOLLUSCA (continued)								
Sphaeriidae								
Sphaerium striatinum (Lamarck)		X				X		
S. transversum (Say)	X	X	X	X	X	X	X	X
Sphaerium spp. Scopoli		X		X				
Unionidae								
Lampsilis ovata ventricosa (Barnes)				X				
Leptodea fragilis (Rafinesque)		X				X		
Coliguaria reflexa Rafinesque		X						
ARTHROPODA								
Isopoda								
Asellidae								
Asellus sp. Geoffrey St. Hillaire			X	X		X		
Insecta								
Odonata								
Coenagrionidae								
Argia apicalis (Say)				X				
A. translata Hagen		X						
Gomphidae								
Gomphus (Gomphurus) vastus Walsh								X
G. (Gomphurus) sp. cf. consanguis Selys		X		X				X
G. (Stylurus) notatus Rambur				X				
Gomphus sp. Leach				X		X		
Ephemeroptera								
Baetidae								
Baetis sp. Leach		X						
Caenidae								
Caenis sp. Stephens	X	X	X	X		X	X	X
Ephemeridae								
Hexagenia limbata (Serville)	X	X	X	X	X	X	X	X

Sheet 3 of [illegible]

Taxa	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Ephemeridae (continued)								
Pentagenia *vittigera* Walsh	X	X	X	X		X	X	
Potamanthus sp. Pictet		X	X					
Heptageniidae								
Anepeorus sp. McDunnough		X				X		
Stenonema sp. 1 Traver	X	X	X	X		X	X	
S. sp. Traver	X	X		X				
Siphlonuridae								
Isonychia spp. 1 Eaton		X		X				
Tricorythidae								
Tricorythodes sp. Ulmer								X
Hemiptera								
Corixidae								
[illegible] [illegible] (Fuller)			X					
Trichocorixa sp. Kirkaldy	X							
Plecoptera								
Perlidae				X				
Coleoptera								
Elmidae								
Ancyronyx *variegatus* (Germar)		X	X	X				
Macronychus *glabratus* Say			X					
S. *vittipennis* Zimmermann		X		X				
Stenelmis sp. cf. *vittipennis* Zimmermann		X	X	X		X	X	X
Hydrophilidae								
Berosus sp. Leach		X						
Trichoptera								
Hydropsychidae								
Cheumatopsyche *campyla* Ross	X	X						
Cheumatopsyche sp. Wallengren	X	X	X	X		X	X	X
Hydropsyche *frisoni* Ross		X	X			X		
H. *orris* Ross	X	X	X	X		X		X

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TABLE 3 (Continued)

Taxa	Mississippi River				Illinois River			
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	X							
[illegible] (continued)								
Neotrichia sp. [illegible]			X					
Leptoceridae								
L. pavida (Hagen)		X	X	X		X		
Leptocella sp. Banks	X							
Polycentropidae								
Polycentropus sp. Curtis		X		X		X		X
Psychomyiidae								
Neureclipsis crepuscularis (Walker)	X	X		X				
Psychomyia sp. Genus B.		X	X					
Diptera								
Ceratopogonidae								
Palpomyia complex		X	X	X			X	
Chaoboridae								
Chaoborus punctipennis (Say)	X	X		X	X	X	X	X
Chironomidae								
Chironominae								
Chironomus attenuatus Walker				X				
Cryptochironomus fulvus Johannsen	X	X	X	X	X	X	X	X
Glyptotendipes (*Phytotendipes*) [illegible] ([illegible])			X					
Micropsectra sp. Kieffer	X							
Polypedilum sp. Kieffer	X	X	X	X	X	X	X	X
Stictochironomus sp. Kieffer	X	X	X	X	X	X		X
Tanytarsus sp. VanderWulp	X	X	X			X		
Tendipedini sp. C. (Roback)	X	X	X	X	X	X		
Xenochironomus festivus Say	X	X	X	X		X		
Orthocladiinae								
Corynoneura sp. Winnertz	X	X			X			
Cricotopus sp. VanderWulp	X	X	X		X	X		
Tanypodinae								
Ablabesmyia sp. Johannsen	X	X	X	X		X	X	X
Clinotanypus pinguis (Loew)		X						

TABLE 8 (Concluded)

Taxa	Mississippi River				Illinois [illegible]			
	Main Channel	River [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Tanypodinae (Continued)								
[illegible] (Loew)	X	X	X	X	X	X	X	X
Procladius [illegible] (Loew)			X	X		X		
Procladius [illegible] Skuse					X	X		
Rhagionidae								
Atherix variegata Walker		X	X	X				
Sciaridae								
Sciara sp. Meigen		X	X					

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Table 9.

Statistical Analysis of Benthos Data from Dikes; Pools 24, 25, and 26, Mississippi River; 1974

	[illegible]			[illegible]			[illegible]		
Variable	$\bar{X}$	SD	No. Obs	$\bar{X}$	SD	No. Obs	$\bar{X}$	SD	No. Obs
[illegible]									
Oligochaeta	424.0	970.4	11	[illegible]	[illegible]	11	[illegible]	[illegible]	[illegible]
Hirudinea	[illegible]	0.0	13	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Pelecypoda	24.2	[illegible]	11	[illegible]	[illegible]	11	[illegible]	[illegible]	[illegible]
Gastropoda	[illegible]	[illegible]	11	[illegible]	[illegible]	11	[illegible]	[illegible]	[illegible]
Crustacea	[illegible]	[illegible]	11	[illegible]	[illegible]	11	[illegible]	[illegible]	[illegible]
Turbellaria	0.4	[illegible]	11	[illegible]	[illegible]	11	[illegible]	[illegible]	[illegible]
Nematoda	[illegible]	0.0	11	[illegible]	[illegible]	11	[illegible]	[illegible]	[illegible]
Insecta	250.1	570.4	11	413.5	[illegible]	11	[illegible]	[illegible]	[illegible]
Total Density	702.1	1148.[illegible]	11	667.4	[illegible]	11	[illegible]	[illegible]	[illegible]
Species Diversity, $\bar{d}$	[illegible]	1.0	11	2.3	[illegible]	11	[illegible]	[illegible]	[illegible]
Evenness Index, e	0.6	0.4	11	[illegible]	[illegible]	11	[illegible]	[illegible]	[illegible]
Number of Taxa	6.2	[illegible]	11	[illegible]	[illegible]	11	[illegible]	[illegible]	[illegible]

NOTE: $\bar{X}$ = mean value
SD = standard deviation
No. obs = number of observations
\- indicates no sample taken

Table 10.

Statistical Analysis of Benthos Data from River Border Areas; Pools 24, 25, and 26, Mississippi River; 1974

	[illegible]			September 1974			[illegible]		
Variable	$\bar{X}$	SD	No. Obs	$\bar{X}$	SD	No. Obs	$\bar{X}$	SD	No. Obs
[illegible]									
Oligochaeta	[illegible]	[illegible]	12	[illegible]	[illegible]	13	[illegible]	[illegible]	25
Hirudinea	[illegible]	1.2	12	[illegible]	[illegible]	13	[illegible]	[illegible]	[illegible]
Pelecypoda	[illegible]	[illegible]	12	[illegible]	[illegible]	13	[illegible]	[illegible]	[illegible]
Gastropoda	[illegible]	[illegible]	12	[illegible]	[illegible]	13	[illegible]	[illegible]	25
Crustacea	[illegible]	0.0	12	0.0	[illegible]	13	[illegible]	[illegible]	25
Turbellaria	[illegible]	[illegible]	12	[illegible]	[illegible]	13	[illegible]	[illegible]	25
Nematoda	0.6	2.0	12	[illegible]	[illegible]	13	[illegible]	[illegible]	25
Insecta	[illegible]	[illegible]	12	[illegible]	[illegible]	13	[illegible]	[illegible]	[illegible]
Total Density	278.[illegible]	625.2	12	[illegible]	[illegible]	13	[illegible]	[illegible]	25
Species Diversity, $\bar{d}$	1.46	0.79	12	1.70	1.25	13	[illegible]	[illegible]	[illegible]
Evenness Index, e	0.55	[illegible]	12	0.56	[illegible]	13	[illegible]	[illegible]	25
Number of Taxa	6.5	5.4	12	[illegible]	[illegible]	13	[illegible]	[illegible]	25

NOTE: $\bar{X}$ = mean value
SD = standard deviation
No. obs = number of observations
\- indicates no sample taken

Table 11.

Statistical Analysis of Benthos Data from Dike, Lower Illinois River, 1974

Variable	July 1974 $\bar{X}$	July 1974 SD	July 1974 No. Obs	September 1974 $\bar{X}$	September 1974 SD	September 1974 No. Obs	Over Periods $\bar{X}$	Over Periods SD	Over Periods No. Obs
Benthos (No./m^2)									
Oligochaeta	[illegible]	0.0	1	[illegible]	[illegible]	1	[illegible]	[illegible]	[illegible]
Hirudinea	0.0	[illegible]	1	0.0	[illegible]	1	0.0	[illegible]	[illegible]
Pelecypoda	[illegible]	[illegible]	1	[illegible]	[illegible]	1	[illegible]	[illegible]	[illegible]
Gastropoda	[illegible]	0.0	1	[illegible]	[illegible]	1	[illegible]	[illegible]	[illegible]
Crustacea	0.0	[illegible]	1	0.0	[illegible]	1	[illegible]	[illegible]	[illegible]
Turbellaria	0.0	[illegible]	1	[illegible]	[illegible]	1	[illegible]	[illegible]	[illegible]
Nematoda	0.0	0.0	1	[illegible]	[illegible]	1	[illegible]	[illegible]	[illegible]
Insecta	156.0	[illegible]	1	[illegible]	[illegible]	1	[illegible]	[illegible]	[illegible]
Total Density	231.0	[illegible]	1	1545.0	[illegible]	1	[illegible]	[illegible]	[illegible]
Species Diversity, $\bar{d}$	2.46	[illegible]	1	2.76	[illegible]	1	[illegible]	[illegible]	[illegible]
Evenness Index, e	0.95	0.0	1	0.65	[illegible]	1	[illegible]	[illegible]	[illegible]
Number of Taxa	6.0	0.0	1	[illegible]	[illegible]	1	[illegible]	[illegible]	[illegible]

NOTE: $\bar{X}$ = mean value
SD = standard deviation
No. Obs = number of observations
\- indicates no sample taken

Table 12.

Statistical Analysis of Benthos Data from River Border Areas, Lower Illinois River, 1974

Variable	July 1974 $\bar{X}$	July 1974 SD	July 1974 No. Obs	September 1974 $\bar{X}$	September 1974 SD	September 1974 No. Obs	Over Periods $\bar{X}$	Over Periods SD	Over Periods No. Obs
Benthos (No./m^2)									
Oligochaeta	227.5	[illegible]	11	[illegible]	[illegible]	11	[illegible]	[illegible]	22
Hirudinea	[illegible]	[illegible]	11	[illegible]	[illegible]	11	[illegible]	[illegible]	22
Pelecypoda	135.1	[illegible]	11	[illegible]	[illegible]	11	76.5	[illegible]	22
Gastropoda	[illegible]	[illegible]	11	[illegible]	[illegible]	11	[illegible]	[illegible]	22
Crustacea	[illegible]	[illegible]	11	[illegible]	[illegible]	11	[illegible]	[illegible]	22
Turbellaria	[illegible]	[illegible]	11	[illegible]	[illegible]	11	[illegible]	[illegible]	22
Nematoda	[illegible]	0.0	11	[illegible]	[illegible]	11	[illegible]	[illegible]	22
Insecta	375.4	617.3	11	[illegible]	[illegible]	11	276.5	[illegible]	22
Total Density	725.5	[illegible]	11	[illegible]	[illegible]	11	551.6	[illegible]	22
Species Diversity, $\bar{d}$	1.26	0.34	11	1.38	[illegible]	11	2.02	[illegible]	22
Evenness Index, e	0.72	0.26	11	0.61	[illegible]	11	0.76	[illegible]	22
Number of Taxa	10.0	3.5	11	[illegible]	[illegible]	11	9.4	[illegible]	22

NOTE: $\bar{X}$ = mean value
SD = standard deviation
No. Obs = number of observations
\- indicates no sample taken

Table 13.

Drift Organisms Collected from Main Channel
Mississippi River Mile 255.5 on 6-7 July 1974

Taxa	Time of Sampling - Organisms per 100 m^3										Total Each Group per 24-hr Period	
	1725		2000		2430		0430		0800			
	Number	Biomass	Number	Biomass	Number	Biomass	Number	Biomass	Number	Biomass	Number	Biomass
Acanthocephala (parasitic worms)	1.0	0.1	-	-	-	-	-	-	-	-	1.0	0.1
Basommatophora (snails)	-	-	-	-	-	-	-	-	2.3	2.3	2.3	2.3
Amphipoda	-	-	-	-	-	-	-	-	1.1	0.7	1.1	0.7
Odonata	-	-	-	-	2.2	33.5	-	-	-	-	2.2	33.5
Ephemeroptera	13.6	6.8	-	-	80.7	36.2	100.5	108.0	38.5	32.5	233.3	183.5
Hemiptera	1.0	0.5	-	-	2.2	2.2	3.3	4.1	4.5	1.1	11.0	7.9
Coleoptera	-	-	-	-	2.2	11.3	3.3	2.8	2.2	5.4	7.7	19.5
Trichoptera	21.2	7.9	-	-	39.0	18.5	74.1	35.7	21.5	9.3	155.8	71.4
Diptera	34.5	1.7	-	-	-	-	46.6	2.7	-	-	81.1	4.4
Perciformes	6.7	2.2	-	-	-	-	1.1	1.8	2.3	0.2	10.1	4.2
Clupeiformes	6.7	6.1	-	-	-	-	6.3	1.8	3.4	2.2	16.4	10.1
Cypriniformes	3.9	61.9	-	-	-	-	-	-	-	-	3.9	61.9
TOTAL NUMBER OF ORGANISMS	88.6		-		126.3		235.2		75.8			
TOTAL BIOMASS		87.2		-		101.7		156.9		[illegible]		

Note: Biomass is expressed as mg dry weight.

Table 14.

Drift Organisms Collected from Side Channel
Mississippi River Mile 255.5 on 6-7 July 1974

Taxa	Time of Sampling - Organisms per 100 m^3 1630 Number	1630 Biomass	2019 Number	2019 Biomass	2400 Number	2400 Biomass	0400 Number	0400 Biomass	0800 Number	0800 Biomass	Total Each Group per 24 hr Period Number	Total Each Group per 24 hr Period Biomass
Basommatophora (snails)	-	-		-	0.8	1.5	2.3	5.6	-	-	3.1	7.1
Amphipoda	1.2	1.9	0.9	0.7	5.4	3.5	0.8	0.5	0.9	2.3	9.2	8.9
Odonata	-	-	-	-	0.8	0.2	3.1	25.2	0.9	14.4	4.8	39.8
Ephemeroptera	69.5	51.7	80.7	167.6	205.3	185.2	58.7	32.6	300.2	238.1	714.4	675.2
Hemiptera	4.8	2.6	4.7	1.1	6.1	1.7	2.4	1.3	7.2	3.6	25.2	10.3
Coleoptera	-	-	-	-	3.2	2.9	4.7	5.6	0.9	0.7	8.8	9.2
Trichoptera	15.1	7.7	20.4	14.6	74.1	49.4	28.2	13.3	46.1	35.6	116.9	120.6
Diptera	212.8	12.9	120.0	5.4	109.0	6.2	154.9	10.2	30.7	2.4	627.4	37.1
Semionotiformes	-	-	-	-	-	-	0.8	2.4	-	-	0.8	2.4
Perciformes	62.3	35.0	7.4	8.6	0.8	0.4	3.1	18.1	17.2	6.7	90.8	24.8
Clupeiformes	58.6	33.4	21.4	15.3	8.5	9.9	16.4	29.5	65.1	125.3	170.0	213.4
Cypriniformes	3.6	1.7	10.2	36.2	6.2	6.4	5.4	3.2	-	-	25.4	47.5
TOTAL NUMBER OF ORGANISMS	427.9		265.7		420.2		286.8		469.2			
TOTAL BIOMASS		146.9		249.5		267.3		147.5		429.1		

Note: Biomass is expressed as mg dry weight.

	Number	Biomass	Number	Biomass	Number	Biomass	Number	Biomass	Number	Biomass	[illegible]	Biomass
Cladocera (Water Fleas)	-		[illegible]	9.3	40.8	0.5		-	69.7	[illegible]	[illegible]	1.2
Ephemeroptera	57.3	55.9		-	-	-	-	-	-	-	[illegible]	83.9
Trichoptera	370.4	[illegible]	[illegible]	87.9	54.4	32.6	366.1	100.9	14.3	9.6	[illegible]	579.5
Diptera	31.3	[illegible]		-	-	-	-	-	-	-	[illegible]	1.5
TOTAL NUMBER OF ORGANISMS	459.0		89.2		95.2		366.1		75.0			
TOTAL BIOMASS		435.9		88.2		33.1		100.9		10.0		

Note: Biomass is expressed as mg dry weight.

Table 16.

Drift Organisms Collected from Side Channel
Mississippi River Mile 255.5 on 12-13 September 1974

Taxa	Time of Sampling - Organisms per 100 m^3										Total Each Group Per 24-hr Period	
	2210		0600		1050		1445		1800			
	Number	Biomass	Number	Biomass	Number	Biomass	Number	Biomass	Number	Biomass	Number	Biomass
Cladocera (water fleas)	-		2.4	6.2	26.8	0.3	40.5	0.4	84.9	0.2	[illegible]	1.1
Odonata	1.6	0.9		-	-	-	-	-	-	-	1.6	0.8
Ephemeroptera	27.2	63.4	4.8	4.9	-	-	-	-	-	-	32.0	64.3
Trichoptera	73.7	56.[illegible]	65.2	46.9	18.8	15.0	18.4	0.8	7.3	8.2	183.[illegible]	127.6
Diptera	9.6	0.2		-	-	-	-	-	-	-	9.6	0.2
TOTAL NUMBER OF ORGANISMS	112.1		72.4		45.6		58.9		92.2			
TOTAL BIOMASS		121.1		48.0		15.3		1.2		8.4		

Note: Biomass is expressed as mg dry weight.

Table 17.

[illegible] Organisms Collected from Main Channel
Illinois River Mile 57.[illegible] on 15-16 September 1974

Taxa	1730 Number	1730 Biomass	2130 Number	2130 Biomass	0215 Number	0215 Biomass	0600 Number	0600 Biomass	1012 Number	1012 Biomass	[illegible] Number	[illegible] Biomass	Total Each Group for Period Number	Total Each Group for Period Biomass
Cladocera ([illegible] fleas)	-						-				1.[illegible]	0.[illegible]	[illegible]	0.1
Heterodonta (freshwater mussels)			[illegible]	7.4	3.7	11.7	7.[illegible]	9.7	1.[illegible]	1.1	[illegible].3	[illegible]	[illegible]	38.6
Coelenterata (Hydra)	159.0	8.5			-	-	-		4.0	0.[illegible]	-		[illegible]	8.6
Odonata	-	-	1.4	6.6	-	-	-			-	-		[illegible]	6.6
Ephemeroptera	-	-	4.1	28.9	7.3	17.9	-		-	-	-		[illegible]	46.8
Coleoptera	-	-	1.[illegible]	1.0	-	-	-		-	-	-	-	[illegible]	1.0
Trichoptera	11.6	9.7	5.5	1.7	5.5	3.7	1.4	0.1	1.3	0.1	-		[illegible]	15.3
Diptera	3.9	0.6	19.2	2.9	47.6	14.1	38.0	9.2	2.6	0.1	1.3	0.1	[illegible]	26.8
TOTAL NUMBER OF ORGANISMS	174.5		35.7		64.1		46.4		9.2		7.9			
TOTAL BIOMASS		18.6		48.5		47.4		19.0		1.4		0.9		

Note: Biomass is expressed as mg dry weight.

Table 18.

Drift Organisms Collected from Side Channel
Illinois River Mile 57.6 on 15-16 September 1974

Taxa	Time of Sampling - Organisms per 100 m³												Total Each Group per 24 Hr Period	
	1800		2235		0242		0639		1038		1418			
	Number	Biomass	Number	Biomass	Number	Biomass	Number	Biomass	Number	Biomass	Number	Biomass	Number	Biomass
Cladocera (water fleas)	-	-	4.6	0.5	9.3	0.5	-	-	-	-	-	-	13.9	1.0
Ephemeroptera	5.0	0.5	9.2	3.3	4.6	0.5	-	-	-	-	-	-	18.8	4.3
Hemiptera	-	-	-	-	4.6	0.5	-	-	-	-	-	-	4.6	0.5
Trichoptera	-	-	4.6	12.5	9.2	4.2	9.4	7.5	-	-	-	-	23.2	24.2
Diptera	-	-	20.2	18.5	143.9	33.0	23.4	7.5	-	-	4.8	0.5	192.3	65.5
TOTAL NUMBER OF ORGANISMS	5.0		38.6		171.6		32.8		-		4.8			
TOTAL BIOMASS		0.5		34.8		44.7		15.0		-		0.5		

Note: [illegible] expressed in mg dry weight.

Table 19.

Drift Organisms Collected from Main Channel
Illinois River Mile 57.6 on 10-11 July 1974

Taxa	Time of Sampling - Organisms per 100 m^3 1620 Number	1620 Biomass	2030 Number	2030 Biomass	2400 Number	2400 Biomass	0400 Number	0400 Biomass	0800 Number	0800 Biomass	1200 Number	1200 Biomass	Total Each Group per 24-hr Period Number	Total Each Group per 24-hr Period Biomass
Cladocera (water fleas)	1972.2	35.4	27,334.9	493.4	125.0	6.3	343.7	14.1	497.5	20.9	542.2	19.5	30,815.5	593.6
Amphipoda	-	-	-	-	1.3	0.1	-	-	-	-	-	-	1.3	0.1
Odonata	-	-		-	-	-	1.1	1.9	-	-	-	-	1.1	1.9
Ephemeroptera	1.2	0.1	6.9	.4	21.5	8.3	59.8	23.6	9.8	1.1	4.6	0.8	103.8	34.3
Hemiptera	-	-	-	-	-	-	1.1	3.5	-	-	-	-	1.1	3.5
Coleoptera	-	-	-	-	-	-	-	-	1.2	1.0	-	-	1.2	1.0
Trichoptera	2.3	0.1	9.1	2.3	21.5	17.6	26.6	17.1	19.6	19.7	4.6	1.8	83.7	58.6
Diptera	-	-	11.4	1.3	20.3	2.9	-	-	6.1	0.1	3.3	.2	41.1	4.5
Cypriniformes	1.2	0.1	29.6	20.3	-	-	-	-	2.5	0.7	-	-	33.3	21.1
Perciformes	-	-	-	-	-	-	1.1	5.7	2.5	6.3	1.1	6.7	4.7	18.7
Clupeiformes	2.3	0.7	63.8	35.3	3.8	2.4	8.9	3.0	6.1	1.4	6.9	5.9	91.8	48.7
TOTAL NUMBER OF ORGANISMS	1979.2		27,455.3		193.4		442.3		145.3		562.7			
TOTAL BIOMASS		40.4		553.0		37.2		68.9		51.2		34.9		

Note: Biomass is expressed as mg dry weight.

Table 20.

Drift Organisms Collected from Side Channel
Illinois River Mile 57.6 on 10-11 July 1974

Taxa	1707 Number	1707 Biomass	2055 Number	2055 Biomass	2435 Number	2435 Biomass	0440 Number	0440 Biomass	0830 Number	0830 Biomass	1150 Number	1150 Biomass	Total Each Group for 24 hr Period Number	Total Each Group for 24 hr Period Biomass
Cladocera (Water fleas)	978.3	79.6	826.6	21.4	3552.2	35.5	25.8	8.7	410.5	33.6	222.7	8.4	6005.9	187.2
Branchiura (Copepoda)	-		1.2	1.0	-	-	1.1	1.2	-		1.4	2.6	3.7	4.8
Amphipoda	-		1.2	0.4	-	-	3.3	3.5	-	-	1.4	0.1	5.9	4.0
Odonata	-		-	-	-	-	2.2	1.7	-	-	-	-	2.2	1.7
Ephemeroptera	2.3	0.1	32.2	13.0	143.3	69.7	85.2	35.7	10.9	1.8	4.2	0.1	274.1	120.4
Hemiptera	-	-	-	-	-	-	1.1	2.7	-	-	1.4	3.5	2.5	6.2
Coleoptera	-	-	-	-	-	-	1.1	1.0	1.1	1.8	-	-	2.2	2.8
Trichoptera	-	-	9.5	7.8	109.3	94.1	14.8	3.6	8.8	8.0	2.5	0.7	145.5	114.2
Diptera	-	-	-	-	14.6	11.0	-	-	7.7	0.1	9.8	0.2	32.1	11.3
Terrestrial Insecta	2.3	4.8	1.2	0.1	-	-	-	-	-	-	1.4	3.0	4.9	7.9
Perciformes	9.1	4.0	5.0	2.5	4.3	1.7	9.0	2.8	2.2	2.7	5.6	4.3	35.2	18.0
Clupeiformes	30.8	62.5	5.0	2.4	5.7	18.1	4.5	0.1	14.2	6.2	5.6	24.8	65.8	114.1
Cypriniformes	1.1	0.2	-	-	-	-	-	-	-	-	-	-	1.1	0.2
TOTAL NUMBER OF ORGANISMS	1015.9		138.0		3827.4		144.1		455.4		258.2			
TOTAL BIOMASS		147.2		48.6		230.1		61.0		54.2		47.2		

Note: Biomass is expressed as mg dry weight

Table 11. Common fish species associated with navigation pools 24, 25, and 26 of the Upper Mississippi and Lower Illinois Rivers

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Petromyzontidae-lampreys

Chestnut lamprey - *Ichthyomyzon castaneus* Girard
Silver lamprey - *Ichthyomyzon unicuspis* Hubbs & Trautman

Acipenseridae-sturgeons

Lake sturgeon - *Acipenser fulvescens* Rafinesque
Shovelnose sturgeon - *Scaphirhynchus platorynchus* (Rafinesque)

Polyodontidae-paddlefishes

Paddlefish - *Polyodon spathula* (Walbaum)

Lepisosteidae-gars

Spotted gar - *Lepisosteus oculatus* (Winchell)
Longnose gar - *Lepisosteus osseus* (Linnaeus)
Shortnose gar - *Lepisosteus platostomus* Rafinesque

Amiidae-bowfins

Bowfin - *Amia calva* Linnaeus

Anguillidae-freshwater eels

American eel - *Anguilla rostrata* (Lesueur)

Clupeidae-herrings

Skipjack herring - *Alosa chrysochloris* (Rafinesque)
Gizzard shad - *Dorosoma cepedianum* (Lesueur)
Threadfin shad - *Dorosoma petenense* (Günther)

Hiodontidae-mooneyes

Goldeye - *Hiodon alosoides* (Rafinesque)
Mooneye - *Hiodon tergisus* Lesueur

Table 11. (Continued)

<u>Umbridae</u>-mudminnows

Central mudminnow - <u>Umbra limi</u> (Kirtland)

<u>Esocidae</u>-pikes

Grass pickerel - <u>Esox americanus vermiculatus</u> Lesueur
Northern pike - <u>Esox lucius</u> Linnaeus

<u>Cyprinidae</u>-minnows and carps

Stoneroller - <u>Campostoma anomalum</u> (Rafinesque)
Goldfish - <u>Carassius auratus</u> (Linnaeus)
White amur - <u>Ctenopharyngodon idella</u> (Valenciennes)
Carp - <u>Cyprinus carpio</u> Linnaeus
Silverjaw minnow - <u>Ericymba buccata</u> Cope
Brassy minnow - <u>Hybognathus hankinsoni</u> Hubbs
Silvery minnow - <u>Hybognathus nuchalis</u> Agassiz
Speckled chub - <u>Hybopsis aestivalis</u> (Girard)
Silver chub - <u>Hybopsis storeriana</u> (Kirtland)
Hornyhead chub - <u>Nocomis biguttatus</u> (Kirtland)
Golden shiner - <u>Notemigonus crysoleucas</u> (Mitchill)
Emerald shiner - <u>Notropis atherinoides</u> Rafinesque
River shiner - <u>Notropis blennius</u> (Girard)
Ghost shiner - <u>Notropis buchanani</u> Meek
Striped shiner - <u>Notropis chrysocephalus</u> (Rafinesque)
Bigmouth shiner - <u>Notropis dorsalis</u> (Agassiz)
Pugnose minnow - <u>Notropis emiliae</u> (Hay)
Spottail shiner - <u>Notropis hudsonius</u> (Clinton)
Red shiner - <u>Notropis lutrensis</u> (Baird & Girard)
Rosyface shiner - <u>Notropis rubellus</u> (Agassiz)
Silverband shiner - <u>Notropis shumardi</u> (Girard)
Spotfin shiner - <u>Notropis spilopterus</u> (Cope)
Sand shiner - <u>Notropis stramineus</u> (Cope)
Redfin shiner - <u>Notropis umbratilis</u> (Girard)
Suckermouth minnow - <u>Phenacobius mirabilis</u> (Girard)
Southern redbelly dace - <u>Phoxinus erythrogaster</u> (Rafinesque)
Bluntnose minnow - <u>Pimephales notatus</u> (Rafinesque)
Fathead minnow - <u>Pimephales promelas</u> Rafinesque
Bullhead minnow - <u>Pimephales vigilax</u> (Baird & Girard)
Creek chub - <u>Semotilus atromaculatus</u> (Mitchill)

Table 21. (Continued)

<u>Catostomidae</u>-suckers

River carpsucker - *Carpiodes carpio* (Rafinesque)
Quillback - *Carpiodes cyprinus* (Lesueur)
Highfin carpsucker - *Carpiodes velifer* (Rafinesque)
White sucker - *Catostomus commersoni* (Lacepède)
Blue sucker - *Cycleptus elongatus* (Lesueur)
Creek chubsucker - *Erimyzon oblongus* (Mitchill)
Lake chubsucker - *Erimyzon sucetta* (Lacepède)
Northern hog sucker - *Hypentelium nigricans* (Lesueur)
Smallmouth buffalo - *Ictiobus bubalus* (Rafinesque)
Bigmouth buffalo - *Ictiobus cyprinellus* (Valenciennes)
Black buffalo - *Ictiobus niger* (Rafinesque)
Spotted sucker - *Minytrema melanops* (Rafinesque)
Silver redhorse - *Moxostoma anisurum* (Rafinesque)
Black redhorse - *Moxostoma duquesnei* (Lesueur)
Golden redhorse - *Moxostoma erythrurum* (Rafinesque)
Shorthead redhorse - *Moxostoma macrolepidotum* (Lesueur)

<u>Ictaluridae</u>-freshwater catfishes and bullheads

Blue catfish - *Ictalurus furcatus* (Lesueur)
Black bullhead - *Ictalurus melas* (Rafinesque)
Yellow bullhead - *Ictalurus natalis* (Lesueur)
Brown bullhead - *Ictalurus nebulosus* (Lesueur)
Channel catfish - *Ictalurus punctatus* (Rafinesque)
Stonecat - *Noturus flavus* Rafinesque
Tadpole madtom - *Noturus gyrinus* (Mitchill)
Freckled madtom - *Noturus nocturnus* Jordan & Gilbert
Flathead catfish - *Pylodictis olivaris* (Rafinesque)

<u>Gadidae</u>-codfishes

Burbot - *Lota lota* (Linnaeus)

<u>Cyprinodontidae</u>-killifishes

Blackstripe topminnow - *Fundulus notatus* (Rafinesque)
Starhead topminnow - *Fundulus notti* (Agassiz)

<u>Poeciliidae</u>-livebearers

Mosquitofish - *Gambusia affinis* (Baird & Girard)

Table 21. (Continued)

Atherinidae-silversides

Brook silverside - *Labidesthes sicculus* (Cope)

Percichthyidae-temperate basses

White bass - *Morone chrysops* (Rafinesque)
Yellow bass - *Morone mississippiensis* Jordan & Eigenmann

Centrarchidae-sunfishes

Rock bass - *Ambloplites rupestris* (Rafinesque)
Green sunfish - *Lepomis cyanellus* Rafinesque
Pumpkinseed - *Lepomis gibbosus* (Linnaeus)
Warmouth - *Lepomis gulosus* (Cuvier)
Orangespotted sunfish - *Lepomis humilis* (Girard)
Bluegill - *Lepomis macrochirus* Rafinesque
Longear sunfish - *Lepomis megalotis* (Rafinesque)
Redear sunfish - *Lepomis microlophus* (Gunther)
Smallmouth bass - *Micropterus dolomieui* (Lacepede)
Largemouth bass - *Micropterus salmoides* (Lacepede)
White crappie - *Pomoxis annularis* Rafinesque
Black crappie - *Pomoxis nigromaculatus* (Lesueur)

Percidae-perches and darters

Mud darter - *Etheostoma asprigene* (Forbes)
Bluntnose darter - *Etheostoma chlorosomum* (Hay)
Fantail darter - *Etheostoma flabellare* Rafinesque
Slough darter - *Etheostoma gracile* (Girard)
Johnny darter - *Etheostoma nigrum* Rafinesque
Orangethroat darter - *Etheostoma spectabile* (Agassiz)
Logperch - *Percina caprodes* (Rafinesque)
Slenderhead darter - *Percina phoxocephala* (Nelson)
River darter - *Percina shumardi* (Girard)
Sauger - *Stizostedion canadense* (Smith)
Walleye - *Stizostedion vitreum vitreum* (Mitchill)

Sciaenidae-drums

Freshwater drum - *Aplodinotus grunniens* Rafinesque

TABLE 22.

TOTAL CATCH DATA OF THE FOUR MAJOR COMMERCIAL FISH SPECIES
FROM POOLS 24, 25, AND 26,
UPPER MISSISSIPPI AND LOWER ILLINOIS RIVERS (1953-1973)
Expressed in Pounds

YEAR	CARP	BUFFALO	CATFISH*	DRUM	COMBINED YEARLY TOTAL
1953	221563	155304	90890	131192	598949
1954	272886	274254	162898	186971	897009
1955	475175	370150	194231	196600	1236156
1956	272684	222096	147018	142148	783946
1957	236747	266506	273476	189335	966064
1958	313869	229657	266589	176485	986600
1959	408886	227298	181165	190801	1008150
1960	524263	247345	184152	151565	1107325
1961	277522	185875	174849	138128	776374
1962	271842	167770	170551	99564	709726
1963	561382	190645	201141	149560	1102728
1964	310698	331977	305340	171072	1319087
1965	652366	274624	227353	152574	1306917
1966	318130	219730	206519	177950	922429
1967	331560	216734	208627	131466	988387
1968	330515	188666	196403	76931	792515
1969	365208	339260	198254	124717	1027439
1970	403613	280918	156977	136076	977584
1971	226676	239139	87553	88482	6418[illegible]
1972	418167	228[illegible]	[illegible]	125183	856952
1973	341025	[illegible]	[illegible]171	131132	729[illegible]

*Includes bullheads

FIGURE 1. YEARLY TOTAL CATCH OF BUFFALO CALCULATED FOR NAVIGATION POOLS 24, 25, AND 26, UPPER MISSISSIPPI AND LOWER ILLINOIS RIVERS

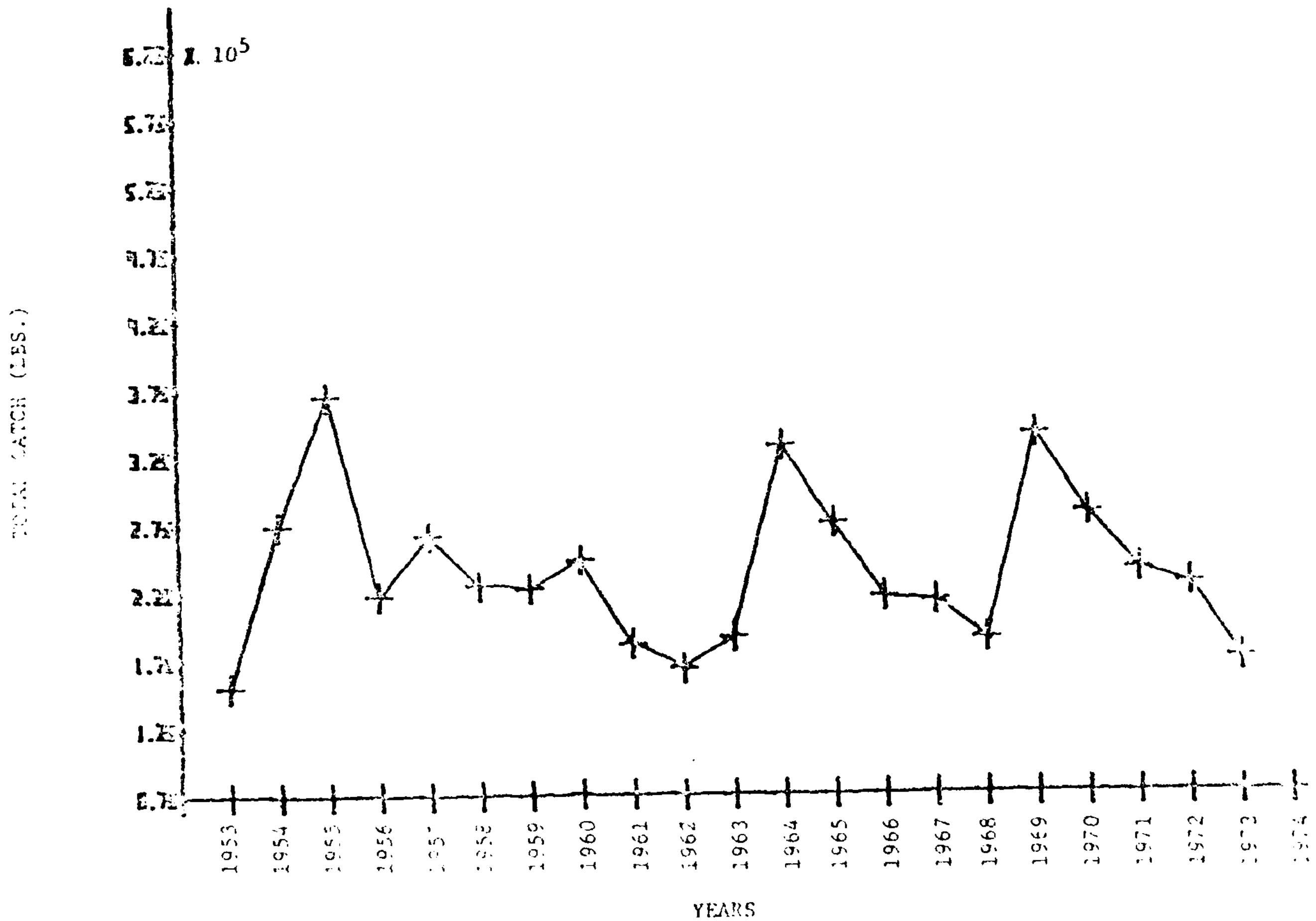

FIGURE 2. YEARLY TOTAL CATCH OF CATFISH CALCULATED FOR NAVIGATION POOLS 24, 25, AND 26, UPPER MISSISSIPPI AND LOWER ILLINOIS RIVERS

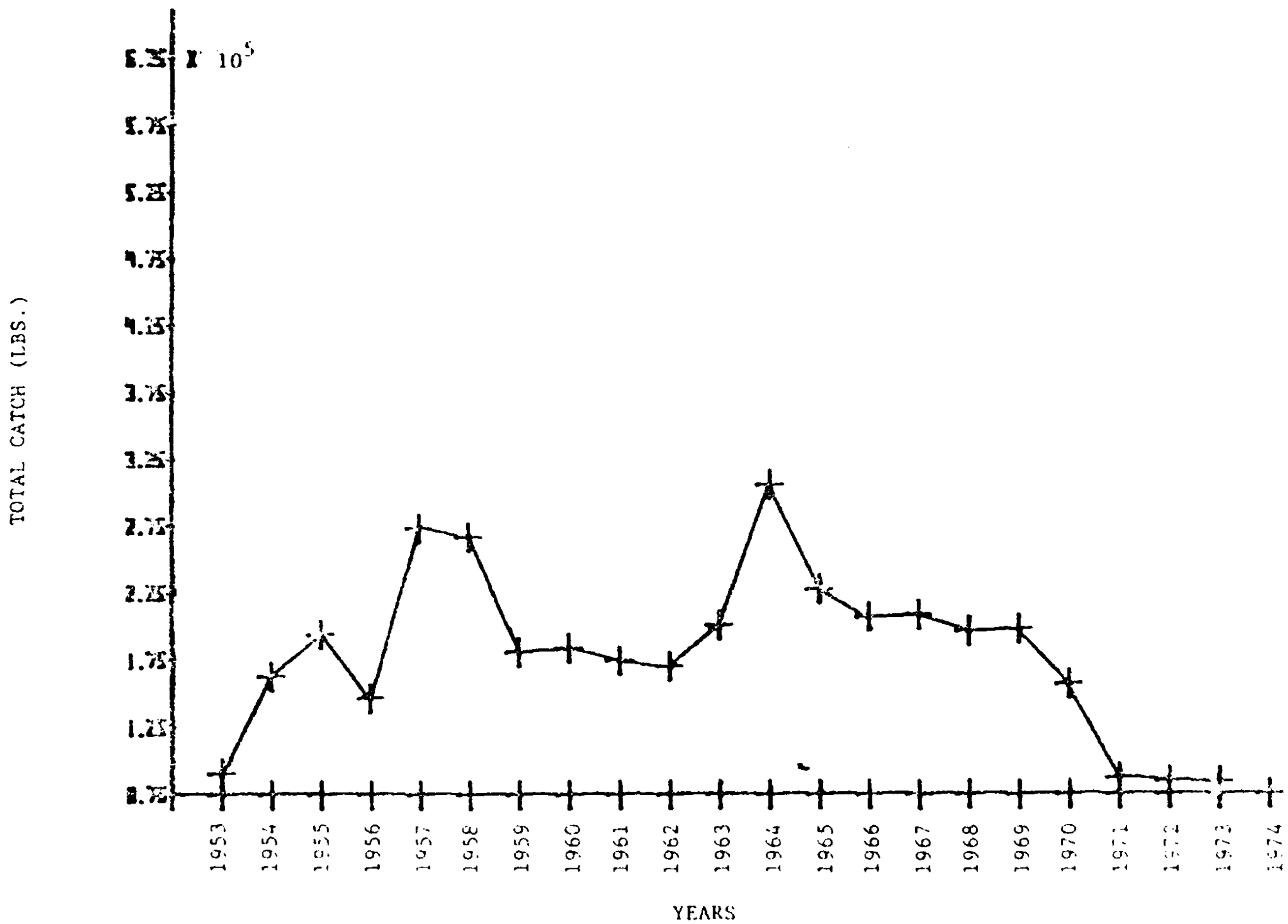

FIGURE 3. YEARLY TOTAL CATCH OF CARP CALCULATED FOR NAVIGATION POOLS 24, 25, AND 26, UPPER MISSISSIPPI AND LOWER ILLINOIS RIVERS

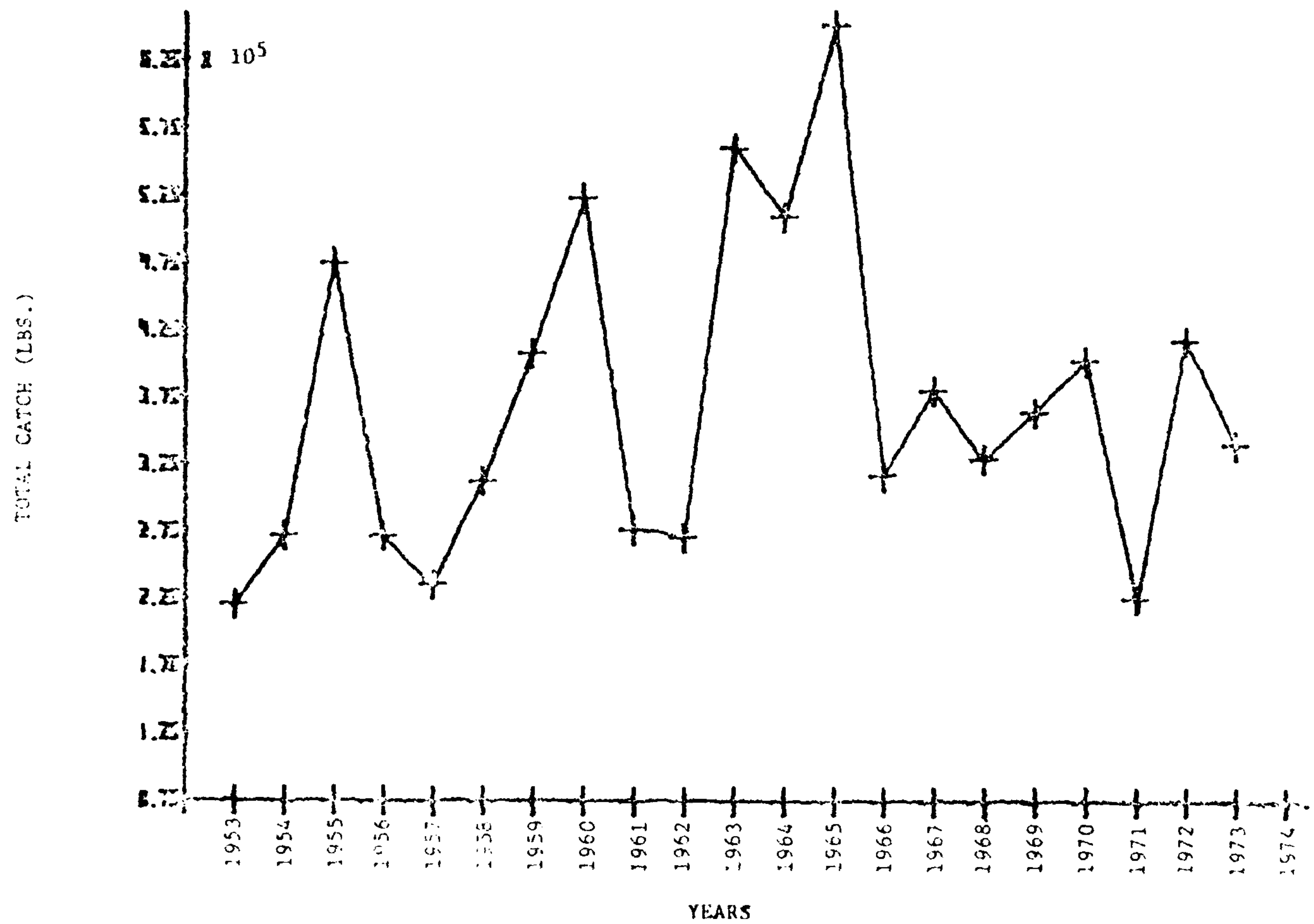

FIGURE 4. YEARLY TOTAL CATCH OF DRUM CALCULATED FOR NAVIGATION POOLS 24, 25, AND 26, UPPER MISSISSIPPI AND LOWER ILLINOIS RIVERS

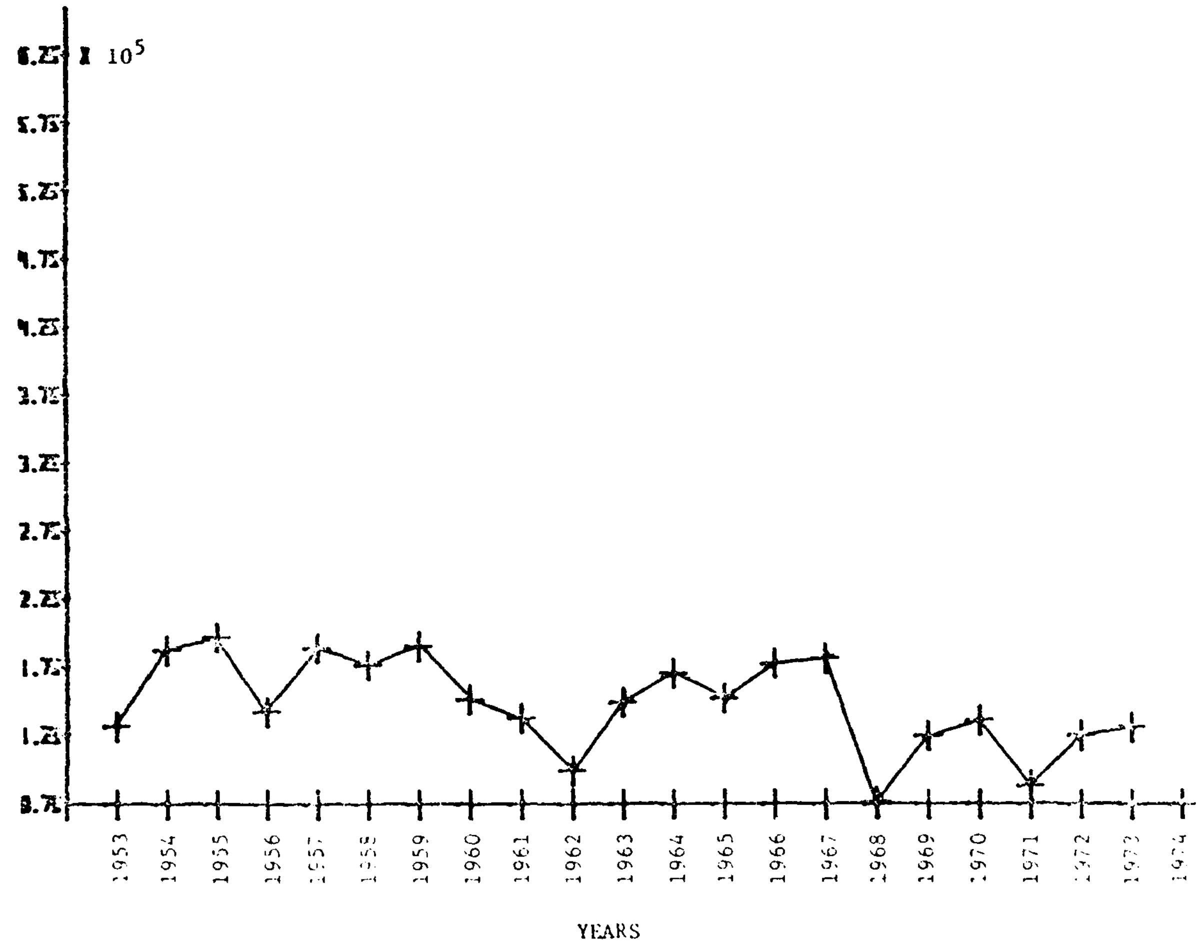

Table 23

Plants Collected in 1974

ACANTHACEAE
- Ruellia humilis Nutt.
- Ruellia strepens L.

ACERACEAE
- Acer negundo L.
- Acer saccharinum L.

AIZOACEAE
- Mollugo verticillata L.

ALISMACEAE
- Alisma plantago-aquatica L.
- Echinodorus cordifolius (L.) Griseb.
- Sagittaria graminea Michx.
- Sagittaria latifolia Willd.

AMARANTHACEAE
- Amaranthus hybridus L.
- Amaranthus spinosus L.
- Amaranthus tamariscinus Nutt.
- Amaranthus tuberculatus (Moq.) Sauer
- Froelichia gracilis (Hook.) Moq.

ANACARDIACEAE
- Rhus aromatica Ait.
- Rhus glabra L.
- Rhus radicans L.

ANNONACEAE
- Asimina triloba (L.) Dunal

APOCYNACEAE
- Apocynum cannabinum L.
- Apocynum sibericum Jacq.

AQUIFOLIACEAE
- Ilex decidua Walt.

ARACEAE
- Arisaema dracontium (L.) Schott.

Table 23 (cont.)

ASCLEPIADACEAE
- Asclepias hirtella (Pennell) Woodson
- Asclepias incarnata L.
- Asclepias purpurascens L.
- Cynanchum laeve (Michx.) Pers.

BALSAMINACEAE
- Impatiens capensis Meerb.
- Impatiens pallida Nutt.

BETULACEAE
- Betula nigra L.

BIGNONIACEAE
- Campsis radicans L. Seem.

BORAGINACEAE
- Heliotropium indicum L.

CAMPANULACEAE
- Campanula americana L.
- Lobelia cardinalis L.
- Specularia perfoliata (L.) A. DC.

CAPPARIDACEAE
- Polanisia dodecandra (L.) DC.

CAPRIFOLIACEAE
- Lonicera japonica Thunb.
- Lonicera morrowi Gray
- Sambucus canadensis L.

CARYOPHYLLACEAE
- Cerastium vulgatum L.
- Dianthus armeria L.
- Lychnis alba Mill.
- Silene stellata (L.) Ait. f.
- Stellaria media (L.) Cyrillo

CELASTRACEAE
- Euonymus americanus L.
- Euonymus atropurpureus Jacq.

Table 23 (cont.)

CERATOPHYLLACEAE
Ceratophyllum demersum L.

CHENOPODIACEAE
Chenopodium album L.
Cycloloma atriplicifolium (Spreng.) Coult.

COMMELINACEAE
Commelina diffusa Burm.

COMPOSITAE
Ambrosia artemisiifolia L.
Ambrosia trifida L.
Arctium minus (Hill) Bernh.
Aster lateriflorus (L.) Britt.
Aster parviceps (Burgess) MacKenz. & Bush
Aster pilosus Willd.
Aster simplex Willd.
Bidens bipinnata L.
Bidens cernua L.
Bidens comosa (Gray) Wieg.
Bidens connata Muhl.
Bidens frondosa L.
Bidens polylepis Blake
Bidens vulgata Greene
Boltonia asteroides (L.) L'Her
Cirsium vulgare (Savi) Tenore
Eclipta alba (L.) Hassk.
Erigeron annuus (L.) Pers.
Erigeron canadensis L.
Erigeron strigosus Muhl.
Eupatorium coelestinum L.
Eupatorium rugosum (Houtt.)
Eupatorium serotinum Michx.
Helianthus annuus L.
Iva ciliata Willd.
Lactuca canadensis L.
Lactuca floridana (L.) Gaertn.
Lactuca scariola L.
Polymnia canadensis L.
Pyrrhopappus carolinianus (Walt.) DC.
Solidago altissima L.
Sonchus oleraceus L.
Vernonia altissima L.
Vernonia baldwin Torr.
Vernonia missurica Raf.
Xanthium chinense Mill.
Xanthium pensylvanicum Wallr.

Table 23 (cont.)

CONVOLVULACEAE
- Convolvulus sepium L.
- Cuscuta cuspidata Engelm.
- Ipomoea hederaceae (L.) Jacq.
- Ipomoea lacunosa L.
- Ipomoea pandurata (L.) G.F.W. Mey.

CORNACEAE
- Cornus drummondi Meyer
- Cornus florida L.

CORYLACEAE
- Alnus serrulata (Ait.) Willd.

CRUCIFERAE
- Barbarea vulgaris R. Br.
- Lepidium virginicum L.
- Rorippa islandica (Oeder) Borbas
- Rorippa sessiliflora (Nutt.) Hitchc.

CUCURBITACEAE
- Citrullus bulgaris Schrad.
- Cucurbita foetidissima HBK
- Sicyos angulatus L.

CUPRESSACEAE
- Juniperus birginiana L.

CYPERACEAE
- Carex squarrosa L.
- Cyperus acuminatus Torr. & Hook.
- Cyperus erythrorhizos Muhl.
- Cyperus esculentus L.
- Cyperus strigosus L.
- Eleocharis macrostachya Britt.
- Eleocharis obtusa (Willd.) Schultes
- Scirpus validus Vahl.

DIOSCOREACEAE
- Dioscorea villosa L.

EBENACEAE
- Diospyros virginiana L.

EQUISETACEAE
- Equisetum arvense L.

Table 23 (cont.)

EUPHORBIACEAE
- Acalypha virginica L.
- Croton glandulosus L.
- Croton monanthogynus Michx.
- Euphorbia dentata Michx.
- Euphorbia humistrata Engelm.
- Euphorbia maculata L.

FAGACEAE
- Quercus bicolor Willd.
- Quercus imbricaria Michx.
- Quercus macrocarpa Michx.
- Quercus marilandica Muenchh.
- Quercus palustris Muenchh.
- Quercus prinoides Willd. (=Quercus muehlenbergii Engelm.)
- Quercus rubra L.
- Quercus shumardii Buckl.
- Quercus stellata Wang.
- Quercus velutina Lam.

GERANIACEAE
- Geranium carolinianum L.

GRAMINEAE
- Agrostis alba L. (=Agrostis stolonifera)
- Bromus inermis Leyss.
- Bromus japonicus Thunb.
- Bromus tectorum L.
- Cinna arundinaceae L.
- Dactylis glomerata L.
- Digitaria ischaemum (Schreb.) Muhl.
- Digitaria sanguinalis (L.) Scop.
- Echinochloa crusgalli (L.) Beauv.
- Eleusine indica (L.) Gaertn.
- Elymus virginicus L.
- Eragrostis cilianensis (All.) Lutati
- Eragrostis hypnoides (Lam.) B.S.P.
- Eragrostis pectinacea (Michx.) Nees
- Festuca arundinaceae Schreb.
- Festuca obtusa Biehler
- Hordeum jubatum L.
- Hordeum pusillum Nutt.
- Leersia lenticularis Michx.
- Leersia oryzoides (L.) Siv.
- Leersia virginica Willd.
- Leptochloa fascicularis (Lam.) Gray
- Leptochloa filiformis (Lam.) Beauv.

Table 23 (cont.)

Muhlenbergia spp.
Panicum capillare L.
Panicum clandestinum L.
Panicum dichotomiflorum Michx.
Panicum gattingeri Wash.
Panicum virgatum L.
Paspalum ciliatifolium Michx.
Phalaris arundinaceae L.
Phleum pratense L.
Poa pratensis L.
Setaria faberii Herrm.
Setaria glauca (L.) Beauv.
Setaria viridis (L.) Beauv.
Sporobolus cryptandrus (Torr.) Gray
Sorghum halepense (L.) Pers.
Spartina pectinata Link.
Sphenopholis obtusata (Michx.) Scribn.
Tridens flabus (L.) Hitchc.

HYPERICACEAE
Hypericum punctatum L.

JUGLANDACEAE
Carya cordiformis (Wang.) K. Koch
Carya illinoensis (Wang.) K. Koch
Carya laciniosa (Michx.) Loud.
Carya ovata (Mill.) K. Koch.
Carya tomentosa Nutt.
Juglans nigra L.

JUNCACEAE
Juncus tenuis Willd.

LABIATAE
Leonurus marrubiastrum L.
Lycopus americanus Muhl.
Lycopus virginicus L.
Mentha arvensis L.
Physostegia formosior Lunell
Physostegia virginiana (L.) Benth.
Prunella vulgaris L.
Scutellaria lateriflora L.
Stachys palustris L.
Stachys tenuifolia Willd.
Teucrium canadense L.

Table 23 (cont.)

LAURACEAE
- Sassafras albidum (Nutt.) Nees
- Lindera benzoin (L.) Blume

LEGUMINOSAE
- Albizzia julibrissin Durazzini
- Amorpha fruticosa L.
- Amphicarpa bracteata (L.) Fern.
- Apios americana Medic.
- Baptista leucantha T. & G.
- Cassia fasciculata Michx.
- Cassia marilandica L.
- Cercis canadensis L.
- Dalea alopecuroides Willd.
- Desmanthus illinoensis (Michx.) MacM.
- Desmodium canescens (L.) DC.
- Desmodium paniculatum (L.) DC.
- Gleditsia triacanthos L.
- Gymnocladus dioica (L.) K. Koch
- Melilotus albus Desr.
- Melilotus officinalis (L.) Lam.
- Penstemon digitalis Nutt.
- Robinia pseudo-acacia L.
- Trifolium campestre Schreb.
- Trifolium pratense L.
- Trifolium repens L.
- Vicia dasycarpa Ten.

LEMNACEAE
- Lemna minor L.
- Spirodela polyrhiza (L.) Schleid.

LILIACEAE
- Asparagus officinalis L.
- Hemerocallis lilio-asphodelus L.
- Smilax lasioneura Hook.
- Smilax tamnoides L.

LYTHRACEAE
- Lythrum alatum Pursh
- Ammania coccinea Rothb.

MALVACEAE
- Abutilon theophrasti Medic.
- Hibiscus militaris Cav.
- Hibiscus trionum L.
- Sida spinosa L.

Table 23 (cont.)

MENISPERMACEAE
    Menispermum canadense L.

MORACEAE
    Maclura pomifera (Raf.) Schneid.
    Morus alba L.
    Morus rubra L.

NAJADACEAE
    Potomogeton pectinatus L.

NYMPHAEACEAE
    Nelumbo lutea (Willd.) Pers.

OLEACEAE
    Forestiera acuminata (Michx.) Poir.
    Fraxinus americana L.
    Fraxinus pennsylvanica Marsh.

ONAGRACEAE
    Jussiaea repens L.
    Ludwigia alternifolia L.
    Oenothera biennis L.
    Oenothera laciniata Hill

OXALIDACEAE
    Oxalis dillenii Jacq.
    Oxalis stricta L.

PHYTOLACCACEAE
    Phytolacca americana L.

PLANTAGINACEAE
    Plantago aristata Michx.
    Plantago rugelii Dcne.

PLATANACEAE
    Platanus occidentalis L.

POLEMONIACEAE
    Phlox divaricata L.

POLYGONACEAE
    Polygonum aviculare L.
    Polygonum coccineum Muhl.
    Polygonum hydropiperoides Michx.
    Polygonum lapathifolium L.

Table 23 (cont.)

Polygonum pensylvanicum L.
Polygonum persicaria L.
Polygonum punctatum Ell.
Polygonum ramosissimum Michx.
Polygonum scandens L.
Polygonum virginianum L.
Rumex crispus L.
Rumex verticillatus L.

PONTEDERIACEAE
Heteranthera limosa (Sw.) Willd.

PORTULACACEAE
Portulaca oleracea L.

PRIMULACEAE
Lysimachia ciliata L.
Lysimachia lanceolata Walt.
Lysimachia nummularia L.

RANUNCULACEAE
Anemone canadensis L.
Clematis pitcheri T. & G.
Delphinium tricorne Michx.
Ranunculus abortivus L.

ROSACEAE
Crataegus mollis (T. & G.) Scheele
Geum canadensis Jacq.
Potentilla norvegica L.
Potentilla recta L.
Potentilla rivalis Nutt.
Prunus serotina Ehrh.
Pyrus ioensis (Wood) Bailey
Rubus spp.

RUBIACEAE
Cephalanthus occidentalis L.
Galium concinnum T. & G.
Spermacoce glabra Michx.

SALICACEAE
Populus deltoides Marsh.
Salix amygdaloides Anders.
Salix interior Rowlee
Salix nigra Marsh.
Salix rigida Muhl.

Table 23 (cont.)

SAURURACEAE
Saururus cernuus L.

SAXIFRAGACEAE
Penthorum sedoides L.

SCROPHULARIACEAE
Lindernia anagallidea (Michx.) Pennell
Lindernia dubia (L.) Barnhardt
Mimulus alatus Ait.
Mimulus ringens L.
Seymaria macrophylla Nutt.
Verbascum blattaria L.
Verbascum thapsus L.

SOLANACEAE
Datura stramonium L.
Physalis longifolia Nutt.
Solanum americanum Mill.
Solanum carolinense L.

TAXODIACEAE
Taxodium distichum (L.) Rich.

TILIACEAE
Tilia americana L.

TYPHACEAE
Typha latifolia L.

ULMACEAE
Celtis laevigata Willd.
Celtis occidentalis L.
Celtis tenuifolia Nutt.
Ulmus americana L.
Ulmus pumila L.
Ulmus rubra Muhl.

UMBELLIFERAE
Chaerophyllum procumbens (L.) Crantz
Cryptotaenia canadensis (L.) CC.
Daucus carota L.
Sanicula canadensis L.
Sium suave Walt.
Torilis japonica (Houtt.) DC.

Table 23 (cont.)

URTICACEAE

Boehmeria cylindrica (L.) Sw.
Laportea canadensis (L.) Gaud.
Pilea pumila (L.) Gray

VERBENACEAE

Lippia lanceolata Michx.
Verbena stricta Vent.
Verbena urticifolia L.

VIOLACEAE

Viola papilionacea Pursh.
Viola sagittata Ait.

VITACEAE

Ampelopsis cordata Michx.
Parthenocissus quinquefolia (L.) Planch.
Vitis cinerea Engelm.
Vitis palmata Vahl.
Vitis vulpina L.

Table 24

Animal Species Observed, Captured, or Expected in Each Habitat Type in the Unprotected Floodplains of the Illinois and Mississippi Rivers With Study Site Designated.

Name	Floodplain Forest	Backwater Areas	Rivers & Streams	Habitat Type Sandbanks & Mudflats	Old Field-Disturbed	Cultivated Field	Buildings
				Mammals			
Family: Didelphidae							
Opossum	MPHCLE*			X**	MH	X	
Family: Soricidae							
Short-tailed shrew	X				X	X	
Least shrew					X	X	
Family: Talpidae							
Eastern mole					X	X	
Family: Vespertilionidae							
Little brown bat	X						X
++Gray bat	X						

*M = Meredosia, P = Pike County Conservation Area, C = Calhoun Point, H = Hardin, L = Cincinnati Landin E = Elsberry, and I = Portage Island.

**X = A species expected in the unprotected floodplain but not observed.

+ = Rare in Illinois and/or Missouri.

++ = Endangered in Illinois and/or Missouri.

Table 24 **(Continued)**

				Habitat Type			
Name	**Floodplain Forest**	**Backwater Areas**	**Rivers & Streams**	**Sandbanks & Mudflats**	**Old Field-Disturbed**	**Cultivated Field**	**Buildings**
+Keen's bat	**X**						**X**
++Indiana bat	**X**						**X**
Small-footed brown bat	**X**						
Silver-haired bat	**X**						
Eastern pipistrelle	**X**						**X**
Big brown bat	**X**						**X**
Red bat	**X**						**X**
+Hoary bat	**X**						
Evening bat	**X**						**X**
Family: Leporidae							
Eastern cottontail	**C**				**MPHCLE**	**MHC**	
Family: Sciuridae							
Woodchuck	**P**				**X**	**X**	
Thirteen-lined ground squirrel					**X**	**X**	

Table 24 (Continued)

Name	Floodplain Forest	Backwater Areas	Rivers & Streams	Habitat Type Sandbanks & Mudflats	Old Field-Disturbed	Cultivated Field	Buildings
Franklin's ground squirrel					X	X	
Eastern chip-munk	X				X		
Eastern gray squirrel	X				X		
Eastern fox squirrel	MPHCLE				MP		
Southern flying squirrel	X						
Family: Geomyidae							
+Plains pocket gopher					X	X	
Family: Castoridae							
Beaver	X	H	MHCEI	X			
Family: Cricetidae							
Western harvest mouse					P	X	
Deer mouse					P	X	

Table 24 (Continued)

Name	Floodplain Forest	Backwater Areas	Rivers & Streams	Sandbanks & Mudflats	Old Field-Disturbed	Cultivated Field	Buildings
			Habitat Type				
White-footed mouse	MPHCLEI				MPHCLE		L
Southern bog lemming					X	X	
Prairie vole					PHC	L	
Pine vole					X		
Muskrat		HCEI	MPHLI	MCE			
Family: Muridae							
Norway rat					X	X	P
House mouse					MPCE	X	X
Family: Zapodidae							
+Meadow jumping mouse					X	X	
Family: Canidae							
Domestic dog	H				CL		
Coyote					X	X	
Red fox					X	X	

Table 24 (Continued)

Name	Floodplain Forest	Backwater Areas	Rivers & Streams	Habitat Type Sandbanks & Mudflats	Old Field-Disturbed	Cultivated Field	Buildings
Gray fox	X				M		
Family: Procyonidae							
Raccoon	MPHCLEI	C		MHCE	MPHE	H	
Family: Mustelidae							
+Long-tailed weasel					X		
Mink	CI	X	X	M			
Striped skunk	MCE				PHE	X	
Spotted skunk					X	X	
Badger					X	X	
++River otter		X	X				
Family: Felidae							
Domestic cat					X	X	X
++Bobcat	X						
Family: Cervidae							
White-tailed deer	MPHCLE			CE	MPHCE	H	
Total species of mammals	28	5	4	6	32	24	11

Table 24 (Continued)

Name	Floodplain Forest	Backwater Areas	Rivers & Streams	Habitat Type Sandbanks & Mudflats	Old Field-Disturbed	Cultivated Field	Buildings
				Birds			
Order: Gaviiformes							
Common loon		X	X				
Red-throated loon		X	X				
Order: Podicipediformes							
Horned grebe		X					
Pied-billed grebe		X	X				
Order: Pelecaniformes							
White pelican		X					
++Double-crested cormorant		X	X				
Order: Ciconiiformes							
Great blue heron	PCE	MEI	PC	E	PC		P
Green heron	CLEI	CEI	I		H		
+Little blue heron		X					
Cattle egret		X			M	X	
Great egret		X	X				

Table 24 (Continued)

Name	Floodplain Forest	Backwater Areas	Habitat Type Rivers & Streams	Sandbanks & Mudflats	Old Field-Disturbed	Cultivated Field	Buildings
Snowy egret		X					
Louisiana heron		X		X			
+Black-crowned night heron	X	X					
Yellow-crowned night heron	C	C					
Least bittern		X					
+American bittern		X					
Wood stork		X					
Glossy ibis		X					
White ibis		X					
Order: Anseriformes							
Mute swan		X					
Whistling swan		X					
Canada goose		X	X	X		X	
Brant		X				X	
White-fronted goose		X				X	

Table 24 (Continued)

Name	Floodplain Forest	Backwater Areas	Rivers & Streams	Habitat Type Sandbanks & Mudflats	Old Field-Disturbed	Cultivated Field	Buildings
Snow goose		X				X	
Mallard	P	C	P	C	P	X	
+Black duck	X	X				X	
Gadwall	X	X					
+Pintail		X				X	
Green-winged teal		X	X				
Blue-winged teal		X				M	
American wigeon		X				X	
+Northern shoveler		X				X	
Wood duck	MH	CLEI	MLE	C	H	M	X
Redhead		X	X				
Ring-necked duck		X	X				
+Canvasback			X				
Greater scaup			X				
Lesser scaup		X	X				
Common goldeneye		X	X				

Table 24 (Continued)

Name	Floodplain Forest	Backwater Areas	Rivers & Streams	Habitat Type: Sandbanks & Mudflats	Old Field-Disturbed	Cultivated Field	Buildings
Barrow's goldeneye			X				
Bufflehead	X	X	X				
Oldsquaw		X	X				
White-winged scoter		X	X				
Surf scoter		X	X				
Common scoter			X				
+Ruddy duck		X	X				
+Hooded merganser	X	X	X				
Common merganser		X	X				
Red-breased merganser		X					
Order: Falconiformes							
Turkey vulture	CL	C	C	C	P	X	
+Black vulture					X	X	X
+Mississippi kite	X		X		X		
Goshawk	X						
++Sharp-shinned hawk	X				X	X	

Table 24 (Continued)

Name	Floodplain Forest	Backwater Areas	Rivers & Streams	Habitat Type Sandbanks & Mudflats	Old Field-Disturbed	Cultivated Field	Buildings
++Cooper's hawk	X				X	X	
Red-tailed hawk	PC				PC	L	
++Red-shouldered hawk	X	X			X	X	
Broad-winged hawk		X			X		
Swainson's hawk					X		
Rough-legged hawk					X	X	
Golden eagle			X	X			
++Bald eagle		X	X	X			
+Marsh hawk		X			X		
++Osprey		X	X				
++Peregrine falcon	X		X	X			
Merlin					X		
American kestrel					E	L	
Order: Galliformes							
Bobwhite	MPL				MPLE	E	L

Table 24 (Continued)

Name	Floodplain Forest	Backwater Areas	Rivers & Streams	Habitat Type Sandbanks & Mudflats	Old Field-Disturbed	Cultivated Field	Buildings
Ring-necked pheasant	X				X	X	
Order: Gruiformes					X		
Whooping crane		X			X		
Sandhill crane		X					
+King rail		X					
Virginia rail		X					
Sora		X					
Yellow rail		X				X	
Purple gallinule		X					
Common gallinule		X					
American coot		X				X	
Order: Charadriiformes							
Semipalmated plover				X			
Piping plover				X			
Killdeer		C		X	X	X	
American golden plover				X	X	X	

Table 24 (Continued)

Name	Floodplain Forest	Backwater Areas	Rivers & Streams	Habitat Type Sandbanks & Mudflats	Old Field-Disturbed	Cultivated Field	Buildings
Black-bellied plover	X	X				X	
Ruddy turnstone				X			
American woodcock	HI				X		
+Common snipe		X		X	X		
++Upland sandpiper					X	X	
Spotted sandpiper	I	CEI	I	ME			
Solitary sandpiper		CE		E			
Willet		X		X			
Greater yellowlegs		X		X		X	
Lesser yellowlegs		C		C			
Pectoral sandpiper		X		X		X	
White-rumped sandpiper				X			
Baird's sandpiper		X		X			
Least sandpiper		C		C			
Dunlin				X			

Table 24 (Continued)

Name	Floodplain Forest	Backwater Areas	Rivers & Streams	Habitat Type Sandbands & Mudflats	Old Field-Disturbed	Cultivated Field	Buildings
Short-billed dowitcher				X			
Long-billed dowitcher				X			
Stilt sandpiper		X		X			
Semipalmated sandpiper		X		X			
Western sandpiper				X			
Buff-breasted sandpiper		X		X	X		
Marbled godwit		X		X	X		
Hudsonian godwit		X		X			
Sanderling				X			
American avocet		X					
Black-necked stilt		X					
Wilson's phalarope		X					
Northern phalarope		X					
Parasitic jaeger		X	X				
Glaucous gull				X			

Table 24 (Continued)

Name	Floodplain Forest	Backwater Areas	Rivers & Streams	Habitat Type Sandbanks & Mudflats	Old Field-Disturbed	Cultivated Field	Buildings
Iceland gull		X	X				
Herring gull		X	X	X			
Ring-billed gull		X	X			X	
Laughing gull		X	X		X		
Franklin's gull		X					
Bonaparte's gull		X					
Black-legged kittiwake			X				
Sabine's gull			X				
+Forster's tern		X	X	X			
+Common tern		X	X				
+Least tern			X	X			
Caspian tern			X				
Black tern		X	M	X			
Order: Columbiformes							
Rock dove					X	X	X
Mourning Dove	L	X			L	X	X

Table 24 (Continued)

	Habitat Type						
Name	Floodplain Forest	Backwater Areas	Rivers & Streams	Sandbanks & Mudflats	Old Field-Disturbed	Cultivated Field	Buildings
Order: Cuculiformes							
Yellow-billed cuckoo	MPHCLE1		MPH		P		
Black-billed cuckoo	X						
Order: Strigiformes							
Screech owl	X						X
Great horned owl	I						
Snowy owl					X		
Barred owl	X	X					
+Long-eared owl	X				X		
+Short-eared owl		X			X		
+Saw-whet owl	X				X		
Order: Caprimulgiformes							
Chuck-will's-widow	X						
Whip-poor-will	X				X		
Common nighthawk					X		X

Table 24 (Continued)

Name	Floodplain Forest	Backwater Areas	Rivers & Streams	Habitat Type Sandbanks & Mudflats	Old Field-Disturbed	Cultivated Field	Buildings
Order: Apodiformes							
Chimney swift	X		M				MP
Ruby-throated hummingbird	CLE	E			CLE		L
Order: Coraciiformes							
Belted kingfisher	M	E	ML				
Order: Piciformes							
Common flicker	MHCLEI	C			L		X
Pileated woodpecker	MHCLEI				L		
Red-bellied woodpecker	HCLEI	CE	E		HC		C
Red-headed woodpecker	MHCLEI	C	ML		MHC		CL
+Yellow-bellied sapsucker	X						X
Hairy woodpecker	E	E					
Downy woodpecker	MPHCLEI	E	MPE		PCLE		C
Order: Passeriformes							

Table 24 (Continued)

Name	Floodplain Forest	Backwater Areas	Rivers & Streams	Habitat Type Sandbanks & Mudflats	Old Field-Disturbed	Cultivated Field	Buildings
Eastern kingbird			M		MP		
+Western kingbird			X		X		X
Scissor-tailed flycatcher					X		
Great crested flycatcher	MCLEI	LEI	M		ML		L
Eastern phoebe	MP		MP		M		X
Yellow-bellied flycatcher	X						
Acadian flycatcher	E						
Alder flycatcher		X					
Willow flycatcher	X				X		
Least flycatcher	P				P		
Eastern wood pewee	HCLEI		L		C		C
Vermilion flycatcher			X				
Horned lark	P				P	E	
Tree swallow	I	X	MI				

Table 24 (Continued)

Name	Floodplain Forest	Backwater Areas	Rivers & Streams	Habitat Type Sandbanks & Mudflats	Old Field-Disturbed	Cultivated Field	Buildings
Bank swallow		X	X	X	M		
Rough-winged swallow	MHCLEI	CEI	HCLEI	C	MCLE		CL
Barn swallow	PCI	PC	PLI		MPCL	X	MPH
Cliff swallow		X	X				
Purple martin	CE		C		CE	M	H
Blue jay	MPHCLEI		ML		MCL		L
Common crow	MCLI		MCLI	C	LE		
+Fish crow				X			
Chickadee spp.	MPHCLEI	E	MPE		MPCL		L
Black-capped chickadee	X				X		X
Carolina chickadee	X				X		X
Tufted titmouse	MPHCLEI	CE	PCI		E		C
White-breasted nuthatch	MPHCLEI	CE	ME		PHLE		M
+Red-breasted nuthatch	X						
+Brown creeper	E						

Table 24 (Continued)

Name	Floodplain Forest	Backwater Areas	Rivers & Streams	Habitat Type Sandbanks & Mudflats	Old Field-Disturbed	Cultivated Field	Buildings
House wren	MPL	M	ML		PL		PL
Winter wren	X						
+Bewick's wren	P		P				X
Carolina wren	PCEI	CLE	PE		PL		X
Long-billed marsh wren		X			X		
Short-billed marsh wren		X			X		
Mockingbird	H				H		
Gray catbird	MP	M	M		M		M
Brown thrasher	L				L		X
American robin	MPHCLEI	CL	CL		MHCL		X
Wood thrush	L				L		X
Swainson's thrush	X						
Gray-cheeked thrush	X						
+Veery	X						
Eastern bluebird	X				X		X

Table 24 (Continued)

Name	Floodplain Forest	Backwater Areas	Rivers & Streams	Habitat Type Sandbanks & Mudflats	Old Field-Disturbed	Cultivated Field	Buildings
Blue-gray gnat-catcher	HCEI	E			CE		
Golden-crowned kinglet	X						
Ruby-crowned kinglet	X						
Water pipit		X				X	
Sprague's pipit					X		
Cedar waxwing	X						X
Northern shrike					X		
+Loggerhead shrike					X		
Starling	CEI	E	CI		C	X	MPHL
White-eyed vireo	PE	E			P		
Yellow-throated vireo	X						
Red-eyed vireo	CI						
Warbling vireo	X			X			
Black-and-white warbler	X						

Table 24 (Continued)

	Habitat Type						
Name	Floodplain Forest	Backwater Areas	Rivers & Streams	Sandbanks & Mudflats	Old Field-Disturbed	Cultivated Field	Buildings
Prothonotary warbler	MHCLEI	CLE	HEI		C		
Worm-eating warbler	X						
Golden-winged warbler	X				X		
Blue-winged warbler	X				X		
Tennessee warbler	X						
Orange-crowned warbler	X						
+Nashville warbler	X	X					
Northern parula warbler	X	X					
Yellow warbler	X						
Magnolia warbler	X						
Black-throated blue warbler	X						
Yellow-rumped warbler	X						

Table 24 (Continued)

	Habitat Type						
Name	Floodplain Forest	Backwater Areas	Rivers & Streams	Sandbanks & Mudflats	Old Field-Disturbed	Cultivated Field	Buildings
Cerulean warbler	X		X				
Yellow-throated warbler	X		X				
Chestnut-sided warbler	X						
Blackpoll warbler	X						
Prairie warbler	X						
Palm warbler		X			X		
Ovenbird	X						
Northern waterthrush		X					
Louisiana water-thrush		X	X				
Kentucky warbler	X						
Common yellowthroat		L			CE		
Yellow-breasted chat	L						
Hooded warbler	X						
Wilson's warbler	X						
Canada warbler	X						

Table 24 (Continued)

Name	Floodplain Forest	Backwater Areas	Rivers & Streams	Habitat Type Sandbanks & Mudflats	Old Field-Disturbed	Cultivated Field	Buildings
American redstart	PC				PC		
House sparrow	MCLE	E	MCL		MPHCE	E	MCL
European tree sparrow							X
Bobolink		X			X		
Meadowlark spp.					P	PLE	
Eastern meadowlark	X	X			X	X	
Western meadowlark					X		
+Yellow-headed blackbird		X					
Red-winged blackbird	MHCLEI	CE	HCLE	HL	MCLE	X	C
Orchard oriole	X				E		
Northern oriole	MPHCLEI		MP		MPHCLE		CL
Rusty blackbird	X	X					
+Brewer's blackbird	X			X	X	X	
Common grackle	MPHCLEI	HI	MPHCLI	H	MPHCLE	PE	L
Brown-headed cowbird					L	X	X
Scarlet tanager	X						

Table 24 (Continued)

	Habitat Type						
Name	Floodplain Forest	Backwater Areas	Rivers & Streams	Sandbanks & Mudflats	Old Field-Disturbed	Cultivated Field	Buildings
Summer tanager	X		X				
Cardinal	MPHCLEI	CLEI	MPHCEI	X	MPHCLE	X	X
Rose-breasted grosbeak	X		M			M	X
Blue grosbeak	X				X		
Indigo bunting	MPHCLEI	C	MPCEI		MPHCLE	L	P
Dickcissel			E		MP	HL	
Evening grosbeak	X						
Purple finch	X						
Pine grosbeak	X						
Pine siskin	X				X	X	
American goldfinch	MPHCLI		MPI		PHCLE	M	C
Red crossbill	X						
White-winged crossbill	X						
Green-tailed towhee	X						
Rufous-sided towhee	M		M				

Table 24 (Continued)

Name	Floodplain Forest	Backwater Areas	Rivers & Streams	Habitat Type Sandbanks & Mudflats	Old Field-Disturbed	Cultivated Field	Buildings
Savannah sparrow					X	X	
Grasshopper sparrow					X		
++LeConte's sparrow		X			X		
Henslow's sparrow					X		
Nelson's sparrow		X					
Vesper sparrow					X	X	
Lark sparrow	X				X	X	
Dark-eyed junco	X				X	X	X
Tree sparrow	x				X	X	
Chipping sparrow	X				X		
Clay-colored sparrow					X		
Field sparrow					P	L	
White-crowned sparrow	X				X		
White-throated sparrow	X				X		
Fox sparrow					X		

Table 24 (Continued)

Name	Habitat Type: Floodplain Forest	Backwater Areas	Rivers & Streams	Sandbanks & Mudflats	Old Field-Disturbed	Cultivated Field	Buildings
Lincoln's sparrow			X		X		
Swamp sparrow	P	X		X	P		
Song sparrow	MPCL		PLE	X	MPCLE	X	P
Lapland longspur					X	X	
Smith's longspur					X		
Snow bunting					X	X	
Total Species of Birds	142	141	91	50	123	60	50

Table 24 (Continued)

Name	Floodplain Forest	Backwater Areas	Rivers & Streams	Habitat Type Sandbanks & Mudflats	Old Field-Disturbed	Cultivated Field	Buildings
			Amphibians and Reptiles				
Family: Ambystomatidae							
Spotted salamander	X	X	X				
Small-mouthed salamander	X	X					
Eastern tiger salamander	X	X					X
Family: Salamandridae							
Central newt	X	X					
Family: Plethodontidae							
Long-tailed salamander			X				
+Dark-sided salamander	X		X				
Red-backed salamander			X				
Family: Proteidae							
Mudpuppy		X					
Family: Sirenidae							
Western lesser siren		X					

Table 24 (Continued)

Name	Floodplain Forest	Backwater Areas	Rivers & Streams	Habitat Type Sandbanks & Mudflats	Old Field-Disturbed	Cultivated Field	Buildings
Family: Bufonidae							
American toad	LEI	X			LE	X	
Dwarf toad	X	X					
Fowler's toad	HLEI	X		E	M	E	
Family: Hylidae							
Blanchard's cricket frog	MPHLEI	X	X		E		
Western chorus frog	P	X					
Upland chorus frog	X	X					
+Illinois chorus frog		X		X			
Northern spring peeper	X	X					
Eastern gray treefrog	HLE	X		X			
Family: Ranidae							
Northern crayfish frog	X	X		X			

Table 24 (Continued)

Name	Floodplain Forest	Backwater Areas	Rivers & Streams	Habitat Type Sandbanks & Mudflats	Old Field-Disturbed	Cultivated Field	Buildings
Bullfrog		MPHCLEI	MLEI	C			
Green frog		E	X				
Pickerel frog		CL	X				
Northern leopard frog		MPHLI	E		ME	E	
Southern leopard frog	C	LEI	X		E	E	
Family: Chelydridae							
Common snapping turtle		L	X				
++Alligator snapping turtle		X	X				
Family: Kinosternidae							
Stinkpot		E	X				
+Illinois mud turtle		X	X	X			
+Mud turtle		X	X	X			
Family: Testudinidae							
++Blanding's turtle		X		X			

Table 24 (Continued)

	Habitat Type						
Name	Floodplains Forest	Backwater Areas	Rivers & Streams	Sandbanks & Mudflats	Old Field-Disturbed	Cultivated Field	Buildings
Eastern box turtle	X				X		
Three-toed box turtle	X				X		
Ornate Box turtle					X	X	
Midland painted turtle		MPCI	MP	X			
Western painted turtle		L	X	X			
Red-eared turtle		MCLE	MHL	C			
+Slider		X		X			
False map turtle		L		X			
Quachita map turtle		C	X	X			
Map turtle		HLEI	L	X			
Mississippi map turtle		X		X			
Family: Trionychidae							
Smooth softshell		X	X	X			

Table 24 (Continued)

			Habitat Type				
Name	Floodplain Forest	Backwater Areas	Rivers & Streams	Sandbanks & Mudflats	Old Field-Disturbed	Cultivated Field	Buildings
Eastern spiny softshell		X	X	X			
Family: Iguanidae							
Northern fence lizard					X		
Family: Anguidae							
+Western slender glass lizard						X	
Family: Teiidae							
Six-lined racerunner				X	L	X	
Family: Scincidae							
Ground skink	X						
Five-lined skink					X		
Broad-headed skink					X		
Family: Colubridae							
Midwest worm snake	X						
+Western worm snake	X						

Table 24 (Continued)

Name	Habitat Type						
	Floodplain Forest	Backwater Areas	Rivers & Streams	Sandbanks & Mudflats	Old Field-Disturbed	Cultivated Field	Buildings
Northern ringneck snake					X		
Prairie ringneck snake					X		
++Plains hognose snake				X	X		
Eastern hognose snake	X				X	X	
Rough green snake					X		
+Western smooth green snake					X	X	
Eastern yellow-bellied racer					M	X	
+Great plains rat snake	X				X		
Black rat snake					PLE		L
Western fox snake					X	X	
Bullsnake					X	X	
Prairie kingsnake					X	X	

Table 24 (Continued)

Name	Floodplain Forest	Backwater Areas	Rivers & Streams	Habitat Type Sandbanks & Mudflats	Old Field-Disturbed	Cultivated Field	Buildings
Speckled kingsnake					X		
Eastern milk snake					X	X	
Red milk snake					X	X	
Western ribbon snake		X		X			
Eastern plains garter snake		X	X		X	X	
Eastern garter snake	HL	E			M		X
++Northern lined snake					X		X
Western earth s-ake					X		
Midland brown snake	X					X	
Northern red-bellied snake	X					X	X
Yellow-bellied water snake		CLEI		X			
Graham's water snake		X		X			

Table 24 (Concluded)

Name	Floodplain Forest	Backwater Areas	Rivers & Streams	Sandbanks & Mudflats	Old Field-Disturbed	Cultivated Field	Buildings
Diamond-backed water snake		MCLI	H	X			
Northern water snake		CL	L	X			
Midland water snake			X	X			
Family: Crotalidae							
Northern copper-head	H				X		
+Eastern massasauga		X				X	
++Timber rattle-snake	X				X		
Total Species of Amphibians and Reptiles	27	45	26	26	33	19	5
Grand Total all species expected and observed	197	191	121	82	188	103	66
Grand Total all species observed	80	58	53	19	81	22	29

Table 25. Estimated annual small game mammal harvest for the Illinois counties of the study area.[1]

County	Rabbit[2]		Squirrel[2]		Raccoon[3]		Fox (Red & Gray)[4]	
	$\bar{X}$ Annual Harvest	Percent of Total Harvest	$\bar{X}$ Annual Harvest	Percent of Total Harvest	$\bar{X}$ Annual Harvest	Percent of Total Harvest	$\bar{X}$ Annual Harvest	Percent of Total Harvest
Scott	5,000	0.3	15,900	0.7	535	0.1	74	0.1
Morgan	25,900	1.3	30,400	1.3	5,424	1.2	217	0.3
Pike	43,700	2.2	41,600	1.8	9,105	2.1	333	0.4
Greene	20,700	1.0	31,700	1.4	2,723	0.6	301	0.4
Jersey	11,500	0.6	31,400	1.4	1,134	0.3	295	0.4
Brown	3,600	0.2	14,400	0.6	2,587	0.6	481	0.6
Cass	11,100	0.6	26,100	1.1	4,462	1.0	290	0.4
Calhoun	4,600	0.2	45,000	2.0	2,553	0.6	316	0.4
Madison	44,400	2.2	44,700	2.0	5,492	1.2	421	0.5
Total	170,500	8.6	281,200	12.3	34,015	7.7	2,728	3.5

[1] After J. Ellis, Wildlife Biologist, Illinois Dept. of Conservation, personal communication, 27 September 1974.

[2] Mean number harvested per year for 1970 through 1972.

[3] Mean number harvested per year for 1963 through 1972.

[4] Mean number harvested per year for 1967 through 1972.

Table 26. Estimated small game mammal harvest for the Northeast Riverbreaks Region of Missouri, 1973-1974.[1,2]

Species	Total Hunters	Average Daily Bag	Average Season Bag	Average Hunter Days Afield	Estimated Total Harvest	Estimated Total Harvest for Study Area Counties
Rabbit	52,325	1.66	9.16	5.53	479,481	95,896
Squirrel	38,986	1.59	10.62	6.69	414,156	82,831
Woodchuck	4,649	0.59	3.83	6.53	17,790	3,558
Raccoon	7,686	1.31	12.20	9.35	93,782	18,756
Fox (Gun)	2,479	0.25	1.33	5.33	1,735	347

[1]Sampson (1974).
[2]The Missouri counties of the study area constitute about 20 percent of the Northeast Riverbreaks Region.

Table 27. Annual hunter days afield and the estimated total annual expenditure for small game mammal hunting in the Missouri and Illinois counties of the study area.

	Annual Hunter Days Afield	
Game Species	Missouri (N. E. River-breaks Region)[1]	Illinois (Counties of Study Area)
Rabbit	289,357	156,200[2]
Squirrel	260,816	126,400[2]
Woodchuck	30,358	--
Raccoon	71,864	26,192[3]
Fox	13,213	10,912[4]
Total	665,608	319,704
Total for Missouri counties of the study area[5]:	133,122	
Total annual hunter days afield for Missouri and Illinois counties of the study area:		452,826
Estimated total annual expenditure on small game mammal hunting in the Missouri and Illinois counties of the study area[6]:		3,450,534

[1] Sampson (1974).

[2] Mean number of annual hunter-trips for rabbits and squirrels from 1956-1969 (Preno and Labisky 1971).

[3] Calculated from mean annual harvest for 1963-1972 (unpublished data, 1974, Illinois Dept. of Conservation) multiplied by the number of Hunter Days Afield per raccoon harvested (0.77 day/raccoon) (based on Missouri harvest data in Table 10).

[4] Calculated from mean annual harvest for 1967-1972 (unpublished data, 1974, Illinois Dept. of Conservation) multiplied by the number of Hunter Days Afield per fox harvested (4.0 days/fox) (based on Missouri harvest data in Table 10).

[5] The Missouri counties of the study area constitute about 20 percent of the Northeast Riverbreaks Region; therefore, 665,608 x 0.20 = 133,122 Hunter Days Afield.

[6] Based on 1970 U.S.D.I. National Survey of Fishing and Hunting, which estimates $7.62 spent per day on small game hunting including food, lodging, transportation, equipment, licenses, and related expenditures (U. S. Dept. of the Interior 1972).

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Table 28. 1973 deer harvest and total expenditure by successful hunters in the study area by county.

Illinois Counties	Total Hunters[7]	Firearms Harvest[1]	Missouri Counties	Total Hunters[8]	Firearms Harvest[2]
Scott	332	61	Lincoln	1350	216
Morgan	332	71	Pike	2481	397
Pike	1414	423	Ralls	3125	500
Greene	432	86	St. Charles	1200	192
Jersey	439	40	St. Louis	343	55
Brown	918	263			
Cass	642	118			
Calhoun	665	133			
Madison	223	26			
Total	5397	1221	Total	8499	1360
Total Hunter Days Afield:		16191[3]	Total Hunter Days Afield:		37599[4]
Total Amount Spent by Firearms Hunters[5]:		$282,857.			$656,855.
Total Annual Expenditure by Successful Deer Hunters in the Study Area[6]:			$ 939,712.		

[1]After J. C. Calhoun, Staff Biologist, Division of Wildlife Resources, Illinois Dept. of Conservation, Springfield, letter dated 10 September and 23 October 1974.

[2]After W. R. Porath, Wildlife Research Biologist, Missouri Dept. of Conservation, Columbia, letter dated 22 October 1974.

[3]After J. C. Calhoun, 1975, verbal communication. Each deer hunter spends an average of 3.0 days afield in Illinois.

[4]After E. Glaser, 1975, verbal communication. Each Missouri successful deer hunter spends an average of 3.5 days afield; each unsuccessful hunter 4.6 days.

[5]Based on 1970 U.S.D.I. National Survey of Fishing and Hunting, which estimates $17.47 spent per day for big game hunting, including food, lodging transportation, equipment, licenses, and related expenditures (U.S. Dept. of the Interior 1972).

[6]This total does not include expenditures of bow hunters.

[7]After J. C. Calhoun, 1975, verbal communication

[8]After E. Glaser, Planning Officer, Missouri Dept. of Conservation, Jefferson City, 1975, verbal communication, successful hunters represent 16% of total hunters.

Table 29. Annual hunter days afield and the estimated total annual expenditure for upland game bird hunting in the Missouri and Illinois counties of the study area.

	Annual Hunter Days Afield	
Game Species	Missouri (N. E. River-breaks Region)[1]	Illinois (Counties of Study Area)[2]
Bobwhite	195,228	101,400
Mourning dove	83,733	66,100
Ring-necked pheasant	2,788	10,500
American woodcock	3,844	1,273
Common crow	9,424	--
Total	295,017	179,273
Total for Missouri counties of the study area[3]:	59,003	
Turkey (counties of the study area only)[4]	2,730	--
Grand Total	61,733	179,273
Total annual hunter days afield for Missouri and Illinois counties of the study area:	241,006	
Estimated total annual expenditure on upland game bird hunting in the Missouri and Illinois counties of the study area[5]:	$1,836.46	

[1]Sampson (1974).

[2]Mean number of annual hunter-trips per species from 1970-1972 (unpublished data, 1974, Illinois Dept. of Conservation).

[3]The Missouri counties of the study area constitute about 20 percent of the Northeast Riverbreaks Region; therefore, 295,017 x 0.20 = 59,003 Hunter Days Afield.

[4]The average number of days expended during the 1973 hunting season times the calculated number of permittee hunters in the counties of the study area (Lewis 1974); therefore, 5.19 days x 526 hunters = 2,730 Hunter Days Afield.

[5]Based on 1970 U.S.D.I. National Survey of Fishing and Hunting, which estimates $7.62 spent per day on small game hunting including food, lodging, trasportation, equipment, licenses, and related expenditures (U. S. Dept. of the Interior 1972).

Table 30. Estimated annual upland game bird harvest for the Illinois counties of the study area.[1,2]

County	Bobwhite		Mourning Dove		Ring-necked Pheasant		American woodcock	
	$\bar{X}$ Annual Harvest	Percent of Total Harvest	$\bar{X}$ Annual Harvest	Percent of Total Harvest	$\bar{X}$ Annual Harvest	Percent Total Harvest	$\bar{X}$ Annual Harvest	Percent of Total Harvest
Scott	8,600	0.4	31,400	1.3	100	0.1	0	0.0
Morgan	34,100	1.6	42,200	1.7	2,000	0.2	817	4.4
Pike	60,000	2.8	40,500	1.7	0	0.0	115	0.6
Greene	59,100	2.8	22,600	0.9	0	0.0	66	0.4
Jersey	12,000	0.6	11,500	0.5	0	0.0	0	0.0
Brown	10,100	0.5	200	0.1	0	0.0	0	0.0
Cass	27,200	1.3	26,700	1.1	3,800	0.4	54	0.3
Calhoun	16,800	0.8	25,900	1.1	0	0.0	108	0.6
Madison	46,900	2.2	75,800	3.1	0	0.0	937	5.0
Total	274,800	13.0	276,800	11.5	5,900	0.7	2,097	11.3

[1]After J. Ellis, Wildlife Biologist, Illinois Dept. of Conservation, personal communication, 27 September 1974.

[2]Mean annual harvest 1970-1972

Table 31. **Estimated** annual upland game bird harvest for the Northeast Riverbreaks Region of Missouri, 1973-1974.[1,2]

Game Species	Total Hunters	Average Daily Bag	Average Season Bag	Average Hunter Days Afield	Estimated Total Harvest	Estimated Total Harvest for Study Area Counties
Bobwhite	35,327	2.6	14.3	5.5	505,176	101,035
Mourning dove	17,230	3.5	16.9	4.9	291,187	58,237
Ring-necked pheasant	1,115	0.6	1.5	2.5	1,673	335
American woodcock	868	0.7	3.1	4.4	2,691	538[3]
Common crow	1,984	0.9	4.0	4.8	7,936	1,587

[1]Sampson (1974).

[2]The Missouri counties of the study area constitute about 20 percent of the Northeast Riverbreaks Region.

[3]Probably greater than 20 percent because of habitat preference (p. 72).

Table 32

Estimated 1973 Wild Turkey Harvest for Lincoln, Pike and St. Charles Counties, Missouri.[1]

Total Hunters	Average Season Bag	Average Hunter Days Afield[2]	Number of Turkeys Harvested
526	0.2	5.2	108

[1]Lewis (1974).
[2]Statewide average per turkey hunter in Missouri during the 1973 hunting season.

Table 33

Waterfowl Use-days on the Lower Illinois River (Grafton to LaGrange, Illinois) During the Fall Migration.[1]

Season[3]	Calculated Waterfowl Use-Days[2]: Dabbling Ducks	Diving Ducks	Geese	Total
1969-1970	5,063,000	358,000	404,000	5,825,000
1970-1971	2,509,000	93,000	171,000	2,773,000
1971-1972	4,161,000	185,000	330,000	4,676,000
1972-1973	4,580,000	196,000	245,000	5,021,000
1973-1974	1,457,000	45,000	439,000	1,941,000

[1]The original census figures were collected by the Illinois Natural History Survey's Waterfowl Census and were provided by the Illinois Department of Conservation.

[2]Figures were rounded to the nearest thousand.

[3]Season dates were as follows: 1969-1970: 5 September 1969 to 5 January 1970
1970-1971: 25 September 1970 to 6 January 1971
1971-1972: 29 September 1971 to 7 January 1972
1972-1973: 4 October 1972 to 8 January 1973
1973-1974: 13 September 1973 to 7 January 1974.

Table 34. Waterfowl use-days on Navigation Pool 24, Mississippi River (Clarksville to Saverton, Missouri) during the fall migration.[1]

Season[3]	Calculated Waterfowl Use-Days[2] Dabbling Ducks	Diving Ducks	Geese	Total
1969-1970	6,623,000	127,000	176,000	6,926,000
1970-1971	6,404,000	46,000	194,000	6,644,000
1971-1972	2,745,000	74,000	142,000	2,961,000
1972-1973	1,503,000	145,000	90,000	1,738,000
1973-1974	1,154,000	21,000	693,000	1,868,000

[1]The original census figures were collected by the Illinois Natural History Survey's Waterfowl Census and were provided by the Illinois Department of Conservation.

[2]Figures were rounded to the nearest thousand.

[3]Season dates were as follows:

1969-1970: 5 September 1969 to 5 January 1970
1970-1971: 25 September 1970 to 6 January 1971
1971-1972: 29 September 1971 to 7 January 1972
1972-1973: 4 October 1972 to 8 Janaury 1973
1973-1974: 13 September 1973 to 7 January 1974.

Table 35. . Waterfowl use-days on Navigation Pool 25, Mississippi River (Winfield to Clarksville, Missouri) during the fall migration.[1]

Season[3]	Calculated Waterfowl Use-Days[2]			
	Dabbling Ducks	Diving Ducks	Geese	Total
1969-1970	2,709,000	842,000	94,000	3,645,000
1970-1971	1,684,000	39,000	79,000	1,802,000
1971-1972	3,168,000	369,000	40,000	3,577,000
1972-1973	1,812,000	146,000	6,000	1,964,000
1973-1974	1,672,000	24,000	9,000	1,705,000

[1]The original census figures were collected by the Illinois Natural History Survey's Waterfowl Census and were provided by the Illinois Department of Conservation.

[2]Figures were rounded to the nearest thousand.

[3]Season dates were as follows:

1969-1970: 5 September 1969 to 5 January 1970
1970-1971: 25 September 1970 to 6 January 1971
1971-1972: 29 September 1971 to 7 January 1972
1972-1973: 4 October 1972 to 8 January 1973
1973-1974: 13 September 1973 to 7 January 1974.

Table 36. Waterfowl use-days on Navigation Pool 26, Mississippi River (Alton, Illinois, to Winfield, Missouri) during the fall migration.[1]

Season[3]	Calculated Waterfowl Use-Days[2] Dabbling Ducks	Diving Ducks	Geese	Total
1969-1970	8,570,000	315,000	484,000	9,369,000
1970-1971	4,777,000	34,000	351,000	5,162,000
1971-1972	3,780,000	--	303,000	4,083,000
1972-1973	3,029,000	--	165,000	3,194,000
1973-1974	6,269,000	30,000	216,000	6,515,000

[1]The original census figures were collected by the Illinois Natural History Survey's Waterfowl Census and were provided by the Illinois Department of Conservation.

[2]Figures were rounded to the nearest thousand.

[3]Season dates were as follows:

1969-1970: 5 September 1969 to 5 January 1970
1970-1971: 25 September 1970 to 6 January 1971
1971-1972: 29 September 1971 to 7 January 1972
1972-1973: 4 October 1972 to 8 January 1973
1973-1974: 13 September 1973 to 7 January 1974.

Table 37. Annual hunter days afield, waterfowl harvest, and the estimated total annual expenditure for waterfowl hunting in the Missouri and Illinois counties of the study area.

State	Annual Hunter Days Afield[1]	Waterfowl Harvest[2]
Missouri	59,252	37,225
Illinois	62,948	39,869
Total	122,200	77,094
Estimated total annual expenditure on waterfowl hunting in the Missouri and Illinois counties of the study area[3]:		$1,189,006

[1]Annual hunter days afield were calculated by multiplying the total duck stamps sold in the counties of the study area (Schroeder et al. 1974) times the average annual waterfowl hunting trips per individual hunter in each state (Carney et al. 1973).

[2]Waterfowl harvest for the study area was determined by multiplying the number of hunter trips (the number of duck stamps times the average number of trips per hunter) by the average success ratio for ducks found on public hunting areas in Illinois (Kennedy et al. 1974) and adding the goose kill (about 0.11 goose per hunter in 1972 from Kennedy et al. 1973) and the coot kill (about 1 coot:8.63 ducks in the Mississippi Flyway from Carney et al. 1973).

[3]Based on 1970 U. S. D. I. National Survey of Fishing and Hunting, which estimates $9.73 spent per day on waterfowl hunting including food, lodging, transportation, equipment, licenses, and related expenditures (U. S. Dept. of the Interior 1972).

Table 38. Percent of each waterfowl category harvested in Illinois, Missouri, and the entire Mississippi Flyway in 1972.[1]

	Percent of Total Harvest							
	Canada Goose	Lesser Snow Goose	White-fronted Goose	Dabbling Ducks	Diving Ducks	Mergansers	Coots[2]	Other
Illinois	7.2	0.5	—	76.8	5.8	0.4	—	9.3
Missouri	15.0	4.7	0.4	65.3	5.4	0.2	—	9.0
Mississippi Flyway	2.9	1.7	0.2	71.5	12.9	0.7	9.9	0.2

[1]Adapted from Sorenson and Carney (1973), Carney et al. (1973), and Sorenson et al. (1973).
[2]The percent of coot harvested was available only at the Flyway level.

Table 39. **Estimated fur harvest and average pelt prices for Illinois counties in the study area, 1973–1974.**[1]

County	1973 Permits	Opossum	Striped Skunk	Muskrat	Raccoon	Mink	Weasel	Red & Gray Fox	Beaver
Scott	27	47	6	455	170	28	—	9	3
Morgan	24	358	47	2,769	1,090	135	—	50	16
Pike	115	685	72	4,242	1,378	116	—	28	63
Greene	78	257	50	4,173	835	198	—	41	3
Jersey	35	135	47	2,832	113	25	3	16	—
Brown	44	182	35	1,510	719	35	—	25	19
Cass	63	182	13	2,082	327	3	—	35	44
Calhoun	17	141	3	396	314	3	—	13	6
Madison	116	389	60	5,247	455	201	19	132	75
Total	519	2,376	333	23,706	5,401	744	22	349	229
Average price per pelt (dollars)		1.26	1.89	2.54	7.36	10.86	0.99	19.72	3.14
Value of pelts (dollars)		2,994	629	60,213	39,751	8,080	22	6,882	719

Total value of pelts for Illinois study area counties: $119,290

[1]Unpublished data, 1974, Illinois Dept. of Conservation.

Table 40. Missouri fur harvest and average pelt prices for counties in the study area, 1973-1974.[1,2]

County	1973 Permits	Opossum	Striped Skunk	Muskrat	Spotted Skunk	Raccoon	Mink	Weasel	Red Fox	Gray Fox	Coyote	Bobcat	Beaver	Badger
Lincoln	101	381	22	1,145	1	3,035	53	1	24	27	59	--	12	1
Pike	79	360	24	805	1	2,945	6	1	18	16	84	--	14	1
Ralls	26	164	2	181	1	1,336	5	--	10	4	87	2	--	--
St. Charles	123	438	10	1,688	2	2,739	46	--	33	28	36	1	8	1
[illegible]	[illegible]	[illegible]	5	689	--	[illegible]	[illegible]	--	39	72	22	21	11	--
[illegible]	411	[illegible]	52	4,508	5	10,974	[illegible]	2	124	147	288	24	45	3
Average price per pelt (dollars)		1.91	2.27	2.24	1.97	8.65	9.20	0.50	17.82	10.33	9.85	9.33	8.20	5.25
Value of pelts (dollars)		2,899	118	10,098	10	94,925	1,058	1	2,210	1,519	2,837	224	369	16

Total value of pelts for Missouri study area counties: $116,284

[1] Sampson (1974).
[2] Average price determined from Winter 1973 price lists for Fur Sections 9, 10, and 10A, Maas and Steffen Furs, St. Louis, Missouri.

Table 41. Number of visits to six divisions of the Mark Twain National Wildlife Refuge spent in wildlife-oriented, nonconsumptive recreation during 1973.[1]

Refuge Division	Total Visits[2]	Wildlife-Oriented Visits[3]	Percent of Total
Calhoun	5,195	77[illegible]	14.9
Batchtown	2,014	2	0.1
Gilbert Lake	7,576	5,2[illegible]	68.8
Cannon	400	19[illegible]	49.5
Delair	14	1[illegible]	100.0
Chautauqua	105,237	45,6[illegible]	43.4
Grand Total	120,436	51,8[illegible]	43.0
Estimated value of wildlife-oriented, nonconsumptive recreation in the study area[4]:		$[illegible]	

[1]After H. A. Lipke, Refuge Manager, Mark Twain National Wildlife Refuge, Quincy, Illinois, letter dated 1 October 19[illegible].

[2]Visits represent individual visitors each day they utilize Refuge lands or facilities.

[3]Nature interpretation, wildlands appreciation, [illegible] photography, and wildlife observation.

[4]Horvath (1973).

Table 42. Number of cases of some wildlife-related diseases of major public health significance reported in Illinois and Missouri, 1963, 1968, and 1973.[1]

Disease	1963		1968		1973	
	Missouri	Illinois	Missouri	Illinois	Missouri	Illinois
Brucellosis	14	26	2	1	4	0
Histoplasmosis	16	16	6	49	--	--
Leptospirosis	1	2	0	1	4	0
Rabies--Animal	178	157	123	135	2	202
Rocky Mountain Spotted Fever	0	0	0	8	9	5
Salmonellosis	102	642	149	1,035	—	19
Tularemia	28	24	8	15	21	1

[1] U. S. Dept. of Health, Education, and Welfare (1963, 1968, 1973a and 1973b).

Table 43. Animal rabies in selected counties of Illinois and Missouri by species, 1963-1974[1,2]

	Illinois Counties								
Year	Brown	Calhoun	Cass	Greene	Jersey	Madison	Morgan	Pike	Scott
1963	0	0	0	1 cat 1 cow	1 dog 1 cow 1 cat	3 skunk	1 cow	0	0
1964	2 cow 1 skunk	0	1 cat	3 skunk	1 cat 1 skunk 3 dog	1 cat 1 skunk 3 dog	1 skunk 1 dog	9 skunk 1 cow	2 skunk
1965	1 cat	1 fox 1 dog	1 skunk	0	1 bat 1 cat 1 fox	1 cat	1 dog 1 skunk 1 cow	11 skunk 2 dog	1 fox
1966	0	1 skunk	0	2 dog	1 cow	3 dog 4 cow 1 pig	3 skunk 1 cow	9 skunk 1 dog 1 cat	0
1967	0	1 skunk	6 skunk 1 fox	2 skunk	2 cat	1 cat 1 fox	3 skunk 1 cow 2 dog	3 skunk	3 skunk
1968	0	0	1 skunk	1 skunk	0	3 fox 1 skunk 3 cow	4 skunk 1 cow	4 skunk	1 cow

[1]After G. W. Lantis, Illinois Department of Agriculture, Division of Meat, Poultry and Livestock Inspection, Springfield, letter dated 9 July 1974.

[2]After W. F. Raithel, Division of Health of Missouri, Jefferson City, letter dated 26 September 1974.

Table 43. (Continued)

	Illinois Counties								
Year	Brown	Calhoun	Cass	Greene	Jersey	Madison	Morgan	Pike	Scott
1969	0	0	1 skunk	1 cat	1 fox 1 skunk	1 cow 1 skunk	1 skunk	0	1 skunk
1970	0	0	0	0	0	2 skunk 1 cat	1 cat	4 skunk 1 fox 1 cow 1 dog	0
1971	1 skunk	1 fox	1 cow 1 skunk	1 cow	1 dog	1 horse 1 skunk 1 dog	1 skunk	10 skunk 1 fox	0
1972	0	0	2 skunk	0	0	5 skunk 1 fox	1 skunk 1 cat	5 skunk 1 fox	0
1973	2 skunk	1 cow	0	1 dog 3 skunk	0	1 fox 1 dog 1 cat 2 skunk	1 skunk	2 skunk	0
1974	2 skunk	--	--	--	1 dog	1 skunk	--	4 skunk	--

Table 43. (Concluded)

Year	Missouri Counties: Lincoln	Pike	Ralls	St. Louis	St. Charles
1963	0	0	0	2 bat 1 skunk 3 cat	0
1964	1 skunk	0	0	0	3 skunk
1965	1 skunk	2 dog	0	3 cat 1 opossum	1 skunk
1966	2 skunk	1 cat	0	1 bat 1 dog	1 cat 1 skunk
1967	2 skunk	0	1 skunk	1 bat	1 fox
1968	1 skunk	0	0	0	0
1969	0	0	0	1 raccoon 1 fox	0
1970	0	0	0	0	0
1971	1 skunk	0	0	0	1 bat
1972	1 skunk	1 cow	0	1 skunk	0
1973	2 dog 3 skunk	1 dog	0	0	3 skunk
1974	1 skunk	--	—	1 bat	1 bat

Table 44. Wildlife-related diseases capable of becoming public health concerns.*

Disease	Etiologic Agent	Common Animal Host	Usual Method of Human Infection
Encephalitis	Virus	Small wild birds, duck, turkey, and pheasant	Mosquito bite
Lymphocytic chorio-meningitis	Virus	Mice, dog, cotton rat, fox, and hog	Food and dust
Murine typhus	*Rickettsia mooseri*	Rats, wild rodents, and rabbits	Flea bite
Psittacosis	Virus	Psittacine birds, chicken, duck, and pigeon	Contact
Ringworm	Various *Microsporum* and *Trichophyton*	Many wild and domestic animals	Contact

*Hull (1963:918-922).

Table 45

Annotated Checklist of Invertebrates of Possible Public Health Concern

The following annotated list discusses only the major groups and public health concerns (adapted from Terpening *et al.*, 1973:187-194).

Class Arachnida

Order Araneida (Spiders)

Family Loxoscleidae

Loxosceles reclusa Gertsch and Mulaik, brown recluse spider. Poisonous. Bite serious, necrotic and ulcerative. Lives in buildings, wood piles, cracks in the ground (Baerg 1959).

Family Theridiidae

Latrodectus mactans (Fab.), black widow spider. Poisonous. Neurotoxic and systemic reaction. Found under stones, in brush piles, and vacant animal burrows (Baerg 1959).

L. variolus Waldsenaer, black widow spider. Probably occurs up the Mississippi Valley to Iowa.

Order Acarida (Mites, Ticks, Chiggers)

Family Ixodidae

Dermacentor variabilis (Say), wood ticks. Transmits causative agent of Rocky Mountain spotted fever; causes tick paralysis (Stannard 1967). Field mice host immature stages. Most mammals except rabbits attacked by adults. Woodland and brushy habitat.

Amblyomma americanum (Linn.), lone star tick. Bite extremely irritating to human skin. Possibly transmits Rocky Mountain spotted fever and tularemia. Attacks rabbits especially. Woodland and brushy habitat (Stannard 1967).

Family Dermanyssidae

Dermanyssus gallinae (DeGeer), chicken mite. Bite in man results in dermatitis. Transmits St. Louis and equine encephalitis. Primarily a chicken parasite (Baker 1956)

Ornithonyssus sylvarium (Cane and Fan.), northern fowl mite. Transmits St. Louis and western equine encephalitis. Parasitizes domestic or wild fowl.

O. bursa (Berlese), fowl parasite. Bite in man causes dermatitis.

Table 45. (Cont.)

Echinolaelaps echidnus (Berlese), spiny rat mite. Reservoir of causative agent of tularemia.

Haemolaelaps glasgowi (Ewing), common rodent mite. Reservoir of causative agent of tularemia.

Family Pyemotidae

Pyemotes ventricosus (Newport), hay itch mite. Causes severe dermatitis and secondary infections. Parasitizes insect larvae which are pests of grains and hay (Baker 1956).

Family Trombiculidae

Trombicula alfreddugesi (Oudemans), chigger. Bites result in dermatitis and an allergic reaction. Many vertebrates parasitized; Man is an accidental host (Baker 1956).

Family Sarcoptidae

Sarcoptes scabei (DeGeer), itch mite. Burrows into skin and causes severe irritation which may lead to secondary infection. Man and domestic animals affected (Baker 1956).

Class Insecta

Order Orthoptera (Grasshoppers and Allies)

Family Blattidae (Cockroaches)

Parcoblatta spp., wood cockroaches. Six species recorded in the woods of the unprotected floodplain. Roaches in general transmit viral, bacterial, fungal, and protozoan diseases (Roth and Willis 1957).

Order Hemiptera (True Bugs)

Family Reduviidae (Assassin Bugs)

Reduvius spp., assassin bugs. Can inflict painful bite; local inflammation and swelling may follow (Horsfall 1962).

Arilus cristatus (Linn.), wheel bug. Can inflict painful bite; local inflammation and swelling may occur (Herms and James 1961). This and the previous species prey on other invertebrates.

Table 45. (cont.)

Order Coleoptera (Beetles)

Family Staphylinidae (Rove Beetles)

Occur around decaying plant and animal material. Some species found in the Mississippi floodplain may transmit anthrax (Herms and James 1961).

Paederus spp. Cause painful blisters upon contact with human skin (Faust et al., 1968).

Family Silphidae (Carrion Beetles)

Silpha spp. and Nicrophorus spp. Transmit anthrax (Horsfall 1962).

Family Dermestidae (Skin Beetles)

Various life stages transmit anthrax (Herms and James 1969); invade the auditory canal of man; cause an allergic reaction, possibly asthma (Faust et al., 1968).

Family Scarabaeidae (Scarab or Lamellicorn Beetles)

Implicated in disease transmission. Scavengers, some carrion and dung feeders (Horsfall 1962).

Family Oedemeridae (False Blister Beetles)

Implicated in disease transmission. Larvae thrive in moist decaying wood, especially driftwood (Faust et al., 1968).

Family Ptinidae (Spider Beetles)

Implicated in disease transmission (Faust et al., 1968).

Family Meldidae (Blister Beetles)

Cause blisters upon contact with human skin (Herms and James 1961).

Family Curculionidae (Weevils)

Some species cause allergic reaction similar to that of the skin beetles (Faust et al., 1968).

Order Lepidoptera (Moths and Butterflies)

Family Noctuidae

With urticating hairs. Contact with skin [illegible] inflammation and possible systemic disturbance (Matheson [illegible]).

Table 45 (cont.)

Order Diptera (Flies)

Family Culicidae (Mosquitoes)

Includes the floodwater mosquitoes who lay eggs in soil which is seasonally flooded; eggs hatch under the stimulus of moisture. 55 species in Illinois, 51 in Missouri. Some of the most important species are listed (Ross and Horsfall 1965, Smith 1955).

Aedes spp. Eggs laid in woodland depressions, ditches, borrow pits, and aritifical containers.

A. aegyptii (Linnaeus). Probably eastern, western, and St. Louis encephalitis. Prefers human blood to blood of other animals.

A. dorsalis (Meigen). Western equine encephalitis and St. Louis encephalitis.

A. thibaulti Dyar and Knab. Painful biter.

Anopheles spp. Transmit tularemia, malaria, and encephalitis. Eggs laid around pools and marshy areas with vegetation.

A. crucians Wiedermann. Transmit malaria.

A. quadrimaculatus Say. Most important malarial vector in southeastern United States. Abundant around suitable breeding areas.

Culex pipiens Linnaeus, northern house mosquito. Western equine and St. Louis encephalitis, possibly tularemia. Breeds in ditches and aritifical containers. Persistent biter.

Culiseta spp. All strains of equine and St. Louis encephalitis.

Family Simuliidae (Black Flies, Gnats)

Bite can be severe and serious, causing extreme pain, itching, and swelling. Larvae attach to rocks or vegetation in running water. Floods may wash in large numbers of eggs; with subsequent flooding they hatch, the larvae develop, and huge swarms of adults may result. Livestock, man, and presumably wild animals are attacked (Herms and James 1961).

Family Chloropidae (Fruit Flies, Eye Gnats)

Hippelates spp., eye gnats. Involved in mechanical transmission of pinkeye (Graham-Smith 1930). Eggs laid on freshly disturbed ground with high moisture content. Larvae found in decaying material (Stone et al., 1965).

Family Tabanidae (Horse Flies, Deer Flies)

Swarm annoyingly, cause painful bites, act as mechanical and cyclic disease vectors. Harrassment of livestock can lead to weakened condition. Eggs deposited on aquatic vegetation or vegetation overhanging water. Larvae found in moist soil, humus, and mud of floodplains and ditches (Anthony 1962).

Table 45 (cont.)

Tabanus spp., horse flies. Transmit anthrax and causative agent of tularemia. Pests around sand areas.

Chrysops spp., deer flies. Transmit anthrax and causative agent of tularemia, and possibly other diseases. Swarm around the head persistently.

Family Muscidae (Muscid Flies)

Responsible or partly responsbile for transmission of typhoid, paratyphoid, cholera, dysentery, salmonella enteris, anthrax, conjunctivitis, poliomyelitis, and tuberculosis (Herms and James 1961, West 1951). Transmit eggs of several parasitic worms. Produce traumatic myiasis and pseudomyiasis (James 1947). Larvae and adults feed on excreta and carrion, adults associate freely with man. Transmission is mechanical or due to regurgitation during feeding (Matheson 1950). Many species in this family are found in the unprotected floodplain, all of which can bring about one or more of the above problems. Includes _Musca domestica_ Linn., the common housefly (West 1951).

Family Hippoboscidae (Louse Flies)

Melanophagus ovinus (Linn.), sheep ked. Bite can cause allergic reaction. Possibly transmits disease as adults are bloodsuckers of birds and mammals (Bequaert 1957).

Pseudolynchia canariensis (Macq.), pigeon fly. Importance similar to that of previous species.

Family Nycteribiidae (Bat Flies)

Basilia boardmani Roy. Possibly aids in maintenance of rabies virus. Ectoparasite of bats (Faust _et al._, 1968).

Family Calliphoridae (Blow Flies)

Carry causative agent of dysentery, probably poliomyelitis and tuberculosis (Herms and James 1961). Larvae feed on excrement, garbage, and carrion. Six species in the unprotected floodplain (Stone _et al._, 1965).

Callitraga americana (Cushing and Patten), primary screw worm. Produces traumatic myiasis in man by laying eggs in open wounds. Domestic and probably wild animals also affected. Most serious myiasis-producing fly in the Midwest (James 1947).

Family Sarcophagidae (Flesh Flies)

Disease transmission probably as in the blow flies. Larvae are scavengers (Horsfall 1962).

Table 45 (cont.)

Order Siphonaptera (Fleas)

Connected with bubonic plague, tularemia, salmonellosis, typhus, and dermatitis. Most birds and mammals in the unprotected floodplain are hosts of fleas (Ewing and Fox 1943).

Order Hymenoptera (Sawflies, Bees, Ants, etc.)

Family Mutillidae (Velvet Ant)

Noted for potent sting. Found in open areas. Parasitize larvae of some Coleoptera and Hymenoptera (Faust *et al*., 1968).

Family Formicidae (Ants)

Capable of painful stings and bites. Three genera in the unprotected floodplain noted for their venom: *Pogonomyrmex*, *Solenopsis*, and *Formica* (Ross *et al*., 1971).

Family Vespidae (Vespoid Wasps)

Vespula spp., bald-faced hornets, yellow jackets. Venomous and aggressive. Most build nests underground (Horsfall 1962).

Polistes spp., paper wasps. Venomous. Build nests in buildings (Horsfall 1962).

Family Sphecidae (Sphecid Wasps)

Potent stings. Nest in wood, often found on flowers (Horsfall 1962).

Family Apidae (Bees)

Bombus spp., bumble bee. Venomous. Ground nester (Faust *et al*., 1968).

Apis mellifera (Linn.), honey bee. Venomous. Partially domesticated, also nests in trees (Faust *et al*., 1968).

Table 46. **Rare, endangered, [illegible] status unknown species of the Upper Mississippi and [illegible] Illinois Rivers.**[1,2,3]

Species	Scientific Name	Status In Illinois	Status In Missouri	Status In United States
Keen's Bat	Myotis keeni (Merriam)	UC[4]	R	--
Hoary Bat	Lasiurus cinereus (Beauvois)	R	R	--
Plains Pocket Gopher	Geomys [illegible] (Shaw)	R	C	--
Meadow Jumping Mouse	Zapus [illegible] (Zimm[illegible])	R	--	--
Long-tailed Weasel	Mustela [illegible]	UC	R	--
Gray Bat	Myotis [illegible] Howell	R	E	--
Indiana Bat	[illegible] Miller [illegible]	E	E	E
River Otter	Lutra canadensis (Schreber)	R	E	--
Bobcat	Lynx [illegible] (Schreber)	E	UC	--
Black-crowned Night Heron	Nycticorax nycticorax hoa[illegible] (Gmelin)	R	--	--
American Bittern	Botau[illegible] [illegible]ginosus (Ra[illegible])	R	--	--
Black Duck	Anas [illegible] Brewster	R	--	--
Canvasback	Aythya [illegible]eria ([illegible])	R	--	--
Hooded Merganser	Lopho[illegible] cucullatus (Li[illegible])	R	--	--
Marsh Hawk	Circus [illegible] hudsonius ([illegible])	R	--	--

[1]Illinois Nature [illegible] Commission (1971).
[2]Missouri Dept. of [illegible] [illegible]tion and U. S. Dept. of Agriculture (1974).
[3]Office of Federal [illegible] (1972).
[4]UC = uncommon; [illegible] = endangered; C = common; SU = status unknown; and (--) = [illegible] been made as to its abundance.

Table 46. (Continued)

Species	Scientific Name	Status In Illinois	Status In Missouri	Status In United States
King Rail	Rallus elegans elegans Audubon	--	R	--
Least Tern	Sterna albifrons athalassos (Burleigh & Lowery)	R	R	--
Long-eared Owl	Asio otus wilsonianus (Lesson)	R	--	--
Short-eared Owl	Asio flammeus flammeus (Pontoppidan)	R	--	--
Saw-whet Owl	Aeglius acadicus acadicus (Gmelin)	R	--	--
Yellow-bellied Sapsucker	Sphyrapicus varius varius (Linnaeus)	R	--	--
Brown Creeper	Certhia familiaris americana (Bonaparte)	R	--	--
Bewick's Wren	Thryomanes bewickii bewickii (Audubon)	R	--	--
Loggerhead Shrike	Lanius ludovicianus migrans (Palmer)	R	--	--
Double-crested Cormorant	Phalacrocorax auritus auritus (Lesson)	E	E	--
Sharp-shinned Hawk	Accipiter striatus velox (Wilson)	R	E	--
Cooper's Hawk	Accipiter cooperii (Bonaparte)	E	E	--
Red-shouldered Hawk	Buteo lineatus lineatus (Gmelin)	E	R	--
Osprey	Pandion haliaetus carolinensis (Gmelin)	E	E	--
Bald Eagle Northern	Haliaetus leucocephalus alasanus (Townsend);	E	R	E
Bald Eagle Southern	H. l. leucocephalus (Linnaeus)	E	E	E

Table 46. (Concluded)

Species	Scientific Name	Status In: Illinois	Missouri	United States
Peregrine Falcon	*Falco peregrinus anatum* Bonaparte	E	E	E
Upland Sandpiper	*Bartramia longicauda* (Bechstein)	E	--	--
Dark-sided Salamander	*Eurycea longicauda melanopleura* (Cope)	R	C	--
Illinois Chorus Frog	*Pseudacris streckeri illinoensis* Smith	R	SU	--
Illinois Mud Turtle	*Kinosternon flavescens spooneri* Smith	R	--	--
Mud Turtle	*Kinosternon subrubrum subrubrum* (Lacepede) x *hippocrepis* (Gray)	R	--	--
Slider	*Pseudemys concinna hieroglyphica* (Holbrook) x *floridana hoyi* (Agassiz)	R	--	--
Western Slender Glass Lizard	*Ophisaurus attenuatus attenuatus* Cope	R	R	--
Western Worm Snake	*Carphophis amoenus vermis* (Kennicott)	R	C	--
Western Smooth Green Snake	*Opheodrys vernalis blanchardi* Grobman	UC	R	--
Eastern Massasauga Rattlesnake	*Sistrurus catenatus catenatus* (Rafinesque)	UC	R	--
Great Plains Rat Snake	*Elaphe gutta emoryi* (Baird & Girard)	R	C	--
Alligator Snapping Turtle	*Macroclemys temmincki* (Troost)	E	R	--
Blanding's Turtle	*Emydoidea blandingi* (Holbrook)	UC	E	--
Plains Hognose Snake	*Heterodon nasicus* (Baird & Girard)	R	E	--
Northern Lined Snake	*Tropidoclonion lineatum lineatum* (Hallowell)	E	UC	--
Timber Rattlesnake	*Crotalus horridus horridus* Linnaeus	E	UC	--

Table 47. Number of bald eagles wintering on the Mississippi River (Navigation Pools 24, 25, and 26) and on the lower Illinois River, 1965-1974. 1, 2, +

	Number of Bald Eagles				
	Mississippi River				
Count Date	Pool 24	Pool 25	Pool 26	*Illinois River*	Total
2-15-65	--	--	--	133	133
2-19-66	26	158	19	45	248
2-18-67	87	**	9	67	163
2-17-68	85	69	19	87	260
2-18-69	76	48	33	88	245
2-20-70	223	**	13	39	275
2-20-71	57	31	25	196	309
2-19-72	47	54	11	71	183
2-18-73	45	24	51	46	166
2-16-74	10	26	26	69	131

[1]After J. Brady, Wildlife Biologist, U. S. Army Corps of Engineers District, St. Louis, Missouri.
[2]Figures for the Illinois River included the floodplain from Peoria to Grafton, Illinois.
**Figures for Pool 25 were combined with those for Pool 24.
+Most of these eagles are believed to be northern bald eagles, although the northern and southern bald eagles cannot be positively identified from a distance.

Table 48 - Numbers and kinds of live mussels taken during the 1966 survey of the Illinois River, from the Alton Pool

	Alton Pool								
	River Mile or Bottomland Lake								
	0.9 to 5.5	10.5 to 15.1	19.2 to 29.0	30.5 to 39.2	40.3 to 48.3	51.0 to 58.9	60.8 to 69.4	70.8 to 79.8	Total From Alton Pool
Fusconaia ebena	1	0	0	0	0	0	0	0	1
Fusconaia f. f. undata	1	3	3	0	1	3	1	14	26
Megalonaias gigantea	31	6	30	21	20	47	24	4	183
Ambiema plicata	177	124	133	100	235	226	432	171	1,598
Quadrula quadrula	29	11	7	22	39	29	94	36	267
Quadrula pstulosa	12	18	13	23	94	67	154	32	413
Quadrula nodulata	6	3	1	6	7	1	25	14	63
Arcidens confragosus	1	20	4	4	9	15	4	1	58
Lasmigona complanata	0	1	0	0	0	0	2	0	3
Anodonta g. gradis	0	0	0	0	0	0	0	0	0
Anodonta g. corpulenta	18	3	1	1	0	1	12	2	38
Anodonta imbecillis	0	0	0	1	0	0	1	0	2
Anodonta suborbiculata	0	0	0	0	0	0	0	0	0
Obliquaria reflexa	20	4	3	0	3	5	5	8	48
Obovaria olivaria	1	0	0	0	0	0	0	0	1
Truncilla truncata	3	0	0	0	0	0	1	4	8
Truncilla donaciformis	0	0	0	0	0	0	1	0	1
Leptodea fragilis	2	3	1	0	2	5	14	10	37
Proptera alala	3	2	0	0	1	2	1	1	10
Proptera laevissima	13	2	0	0	2	0	2	1	20
Carunculina parva	1	0	0	0	0	0	0	0	1
Lampsilis a. f. fallaciosa	7	1	0	0	1	4	4	12	29
Lampsilis r. luteola	0	0	0	0	0	0	0	0	0
Total	326	201	196	178	414	405	777	310	2,807

Source: Starrett, W.C., 1971. A Survey of the Mussesl (Unioncea) of the Illinois River: a Polluted Stream. Illinois Natural History Survey Bulletin, Vol. 30: 5, 267 - 403.

Table 49 - Distribution of mussels in the mainstream of the Illinois River since 1870 in the Alton Pool

Kind of Mussel	Alton Pool
Cumberlandia monodonta	P
Fusconaia ebena	P
Fusconaia flava f. undata	P
Megalonaias gigantea	P
Amblema plicata	P
Quadrula quadrula	P
Quadrula pustulosa	P
Quadrula nodulata	P
Quadrula metanevra	P
Tritogonia verrucosa	P
Cyclonaias tuberculata	P
Plethobasus cyphyus	P
Pleurobema coccineum f. solida	P
Pleurobema pyramidatum	P(?)
Elliptio crassidens	P
Elliptio dilatatus	P
Arcidens confragosus	P
Lasmigona complanata	P
Anodonta gradis gradis	P(?)
Anodonta grandis corpulenta	P
Anodonta imbecillis	P
Anodonta suborbiculata	P
Strophitus undulatus	P
Obliquaria reflexa	P
Obovaria olivaria	P
Actinonaias ligamentina	P
Plagiola lineolata	P
Truncilla truncata	P
Truncilla donaciformis	P
Leptodea fragilis	P
Proptera alata	P
Proptera capax	P
Proptera laevissima	P
Carunculina parva	P
Ligumia recta	P
Lampsilis anodontoides f. anodontoides	P
Lampsilis anodontoides f. fallaciosa	P
Lampsilis radiata luteola	P
Lampsilis ventricosa	P
Lampsilis orbiculata f. orbiculata	P
Lampsilis orbiculata f. higginsii	P
Total Recorded Kinds of Mussels Since 1870	41
Total Recorded Kinds of Mussels Taken Alive in 1966 - 1969	20

Source: Starrett, W.C. 1971. A Survey of the Mussels (Unionca) of the Illinois River: a Polluted Stream. Illinois Natural History Survey Bulletin, Vol. 30: 5, 267 - 403.

APPENDIX D

RARE, ENDANGERED, AND STATUS UNKNOWN SPECIES

OF THE STUDY AREA

RARE, ENDANGERED, AND STATUS UNKNOWN SPECIES OF THE STUDY AREA

Two references provided a majority of the information on the status of the animals of Illinois and Missouri: (1) Rare and Endangered Vertebrates of Illinois (Preliminary Draft), 1971, Illinois Nature Preserves Commission, and (2) Rare and Endangered Species of Missouri, 1974, Missouri Department of Conservation and U. S. Department of Agriculture Soil Conservation Service. Additional species were taken from other competent authorities as cited in the text.

The status of each species was based on the following definitions taken from the above sources:

A species or subspecies was considered rare if it had a restricted habitat, range, or population level in Illinois and/or Missouri such that if (1) the quality of its habitat declines, (2) the extent of its range decreased, or (3) the population level decreased, it could become endangered.

A species or subspecies was considered endangered if it existed in Illinois and/or Missouri with such limited habitat or population level that it was in danger of extirpation in the state. Factors contributing to its status included change in or loss of habitat, human or animal predation, overexploitation, competition, or disease.

A species or subspecies was considered status unknown if a competent authority suggested it to be rare or endangered, but its exact status could not be determined from current information. The species or subspecies should be considered rare or endangered until evidence indicates otherwise.

The state or states listed in parentheses after the name of a species were the locations in which its status was defined.

Mammals*

Rare Species

Keen's Bat *Myotis keeni* (Merriam) (Missouri)

This species ranges throughout southern Canada from Newfoundland to Saskatchewan; in the United States, it is found in the east and central states to the Carolinas, northern Alabama and Georgia,

*Unless otherwise cited all information concerning nomenclature, distribution, range, and ecological requirements was taken from Burt and Grossenheider (1964), Hoffmeister and Mohr (1957), Hall and Kelson (1959), and Schwartz and Schwartz (1959).

eastern Oklahoma, eastern Montana, and Colorado. The Keen's bat presumably occurs statewide in Illinois, although only a few records are available. It is a rare but permanent statewide resident in Missouri. This bat hibernates in caves and mines; in summer it is less colonial and probably utilizes mines, attics, crevices of buildings, and eaves.

Hoary Bat Lasiurus cinereus (Beauvois) (Illinois, Missouri)

The hoary bat occurs throughout most of Canada, all of the United States except southern Florida, and northern Mexico. Its range is considered to be statewide in Illinois and Missouri. This species migrates south in the fall and north again in the spring. The bat is often found in wooded areas. Hoffmeister and Mohr (1957), Schwartz and Schwartz (1959), and Barbour and Davis (1969) all considered the hoary bat to be "rare".

Plains Pocket Gopher Geomys bursarius (Shaw) (Illinois)

The range of the pocket gopher extends throughout the central states east of the Mississippi River, as well as in a narrow band through central Illinois into northwestern Indiana. In Illinois, the pocket gopher occurs in the sandy and black soil areas east and south of the Illinois and Kankakee rivers and in Madison County. Mohr (1946) recorded the pocket gopher from Scott, Morgan, Cass, and Madison counties in Illinois. The exact range in Missouri is uncertain; however, the pocket gopher is fairly common in the northeastern and east-central portions of the state, but occurs only rarely in south-central Missouri. McLaughlin (1958) recorded the pocket gopher from St. Louis County, Missouri. Pocket gophers may be found from hilltops to river bottoms, but they prefer open grasslands, prairies, and pastures with deep moist soils.

Meadow Jumping Mouse Zapus hudsonius (Zimmermann) (Illinois)

This species ranges across northern North America from Alaska to Nova Scotia, south to northern Alabama, and west with a southern boundary of northeastern Oklahoma, Nebraska, part of northern and central Colorado, the eastern half of Wyoming and southeastern Montana. It probably occurs statewide in Illinois. The jumping mouse is thought to be absent from the Mississippi Lowland of Missouri, although presumed to range throughout the rest of the state. Personnel of the Mark Twain Refuge consider it rare on the Refuge (personal communication, 1974, S. M. Ham, Acting Refuge Manager, Mark Twain National Wildlife Refuge). The jumping mouse begins to hibernate in mid-September in Missouri and emerges again in late April or early May. Preferred habitat includes open, grassy, and edge areas; specimens have been reported from grain and hay fields, fence rows, and grassy areas along stream banks. D. F. Hoffmeister (verbal communication, 10 July 1973, Museum of Natural History, University of Illinois, Urbana) believed this species to be rare in parts of Illinois due to habitat destruction.

Long-tailed Weasel *Mustela frenata* Lichtenstein (Missouri)

This weasel occurs throughout the United States, except for the dry southwest, and in most of Mexico. It occurs throughout Illinois and Missouri. Preferred habitats of the long-tailed weasel include woodlands, thickets, brush piles, haystacks, and fence rows near water.

Endangered Species

Gray Bat *Myotis grisescens* Howell (Illinois-Rare, Missouri)

The gray bat ranges throughout Kentucky, Tennessee, central Alabama, northern Arkansas, southeastern Oklahoma, most of Missouri, southern Illinois, and Indiana. Although this bat is likely to occur over the southern half of Illinois, it has only been reported from Pike and Hardin counties. It is known from southern and central Missouri. This bat spends its summers in limestone caverns and may migrate south in the winter, some winter in Illinois caves.

Indiana Bat *Myotis sodalis* Miller and Allen (Illinois, Missouri)

The Indiana bat ranges from New York south to northwestern Florida, west through northern Mississippi to southeastern Oklahoma, and north to southern Wisconsin and east to the coast. This species has been collected in Union, Hardin, LaSalle, and Jo Daviess counties, Illinois. The Illinois River is reported to be a migration route of the Indiana bat in Illinois (Walley 1970). In Missouri, the bat occurs statewide except for the northwestern corner. In late October, the bat moves into caves to hibernate for the winter. Although its summer habitat is unknown, man-made structures and hollow trees are probably utilized. The Indiana bat is listed as an endangered species by the U.S. Fish and Wildlife Service (Office of Federal Register,1972).

River Otter *Lutra canadensis* (Schreber) (Illinois-Rare, Missouri)

The river otter is found in most of Canada and the United States, except for the dry southwest and southern Texas. It is found sporadically in Illinois except the northeastern corner. In Missouri, it is known from the Mississippi Lowlands and along the St. Francis and Missouri rivers. Mohr (1943) reported an otter from the Illinois River near Meredosia. In 1937, the otter was reported as extinct in Missouri (Bennit and Nagel 1937); two had been recorded from Lincoln County in 1934. More recently, the otter was reported from the Mississippi River north of the study area in Whiteside County, Illinois (personal communication, 1973, D.F. Hoffmeister). Preferred habitats of the otter include the borders of streams, rivers, and lakes.

Bobcat _Lynx rufus_ (Schreber) (Illinois)

At present, the bobcat ranges through western, northern, and southern United States and is found in the Mississippi River Valley and Appalachian Mountains. It possibly occupies waterways of wooded regions throughout Illinois. In Missouri, this species occurs in the southeastern portion of the Ozark Highlands and in the Mississippi River Lowlands. R. Spring (verbal communication, 1972, Captain of the _Pathfinder_, U.S. Army Corps of Engineers) reported bobcats along the shore of the Mississippi River. Bobcats prefer heavily forested areas along rivers, and timbered bluffs and slopes interspersed with meadows.

Birds*

Although some birds have been categorized as rare or endangered species by Illinois and Missouri, those considered transients, winter visitants, and accidentals were not included in the following discussion as these birds were not part of the normal environment of the study area.

Rare Species

Black-crowned Night Heron _Nycticorax nycticorax hoactli_ (Gmelin) (Illinois)

The black-crowned night heron breeds throughout extreme southern Canada and south into the contiguous United States. Its habitat is variable, and the bird is not restricted to floodplain areas (Palmer 1962). Although there is little information concerning the decline of this once common species (Cory 1909), land clearing, drainage, lumbering, and real estate development have been suggested (Palmer 1962). This species has been reported in the study area along the levee in St. Charles County, Missouri (Anderson and Bauer 1968). Nesting black-crowned night herons have been recorded in St. Clair County, Illinois; the heronry was located eight miles east of the Mississippi River near the junction of U.S. 50 and State 111 (personal communication, 27 April 1974, Lucas Wrischnik, Secretary, Illinois Audubon Society).

American Bittern _Botaurus lentiginosus_ (Rackett) (Illinois)

This species breeds in the eastern half of the continental United States south of Canada, and in the Pacific coast states south of Washington (Robbins _et al._, 1966). The American bittern nests in marshes, sloughs, and meadows where it feeds on small vertebrates and invertebrates (Palmer 1962).

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*Unless otherwise cited, all information concerning nomenclature, distribution, and range was taken from American Ornithologists' Union (1957).

Black Duck *Anas rubripes* Brewster (Illinois)

This duck winters on the Atlantic coast from southern Labrador to central Florida and inland to east-central Minnesota on the north and southeast Texas on the south (Barske 1968). Several local wintering concentrations occur on the Illinois and Mississippi rivers; one is located at the confluence of the two rivers. Maintenance and/or development of shallow-water habitats along the two rivers should increase the wintering populations in the study area.

Canvasback *Aythya valisineria* (Wilson) (Illinois)

This duck winters on large bodies of water across most of the continental United States south of Canada. Approximately 7,500 canvasbacks are winter residents on the Mississippi River south of the Keokuk Navigation Pool to Alton, Illinois (Bellrose 1968). Although canvasbacks will feed on animal life, they prefer aquatic plants (Mills *et al*., 1966). Mills *et al*., (1966) suggested that the scarcity of aquatic vegetation on the lower Illinois River prevented greater utilization of the area by this species.

Hooded Merganser *Lophodytes cucullatus* (Linnaeus) (Illinois)

Hooded mergansers breed in the southern half of Canada, the northern third of the continental United States, excluding Alaska, and the region north of an area extending from central Alabama to South Carolina. It winters throughout most of the United States but is most common near the southwest and southeast coastal regions (Robbins *et al*., 1966). Since 1965, it has been reported during Christmas bird counts in Calhoun and Jersey counties, Illinois, and in St. Charles County, Missouri (personal commuincation, 1974, S. Vasse, Brussels, Illinois; Cruickshank and Manning 1968). A hooded merganser was observed on a pond at the Delair Division of the Mark Twain National Wildlife Refuge on 28 June 1974. Although there are no data available to explain its population decline, George (1971) listed habitat destruction as a possible cause. This merganser nests in hollow trees or stumps near water.

Marsh Hawk *Circus cyaneus hudsonius* (Linnaeus) (Illinois)

The marsh hawk breeds in the southern two-thirds of Canada, Alaska, the northern half of the continental United States, and California. It winters in the southern two-thirds of the continental United States south of Canada, including Illinois and Missouri, plus the northern third of the states west of Nebraska. The marsh hawk remained the third most common statewide raptor in Illinois between 1903 and 1955 with no apparent drastic changes in population size (Graber and Golden 1960). This hawk is an uncommon winter resident in the St. Louis area with a few breeding records from St. Charles County, Missouri (Anderson and Bauer 1968). During Christmas bird counts, it has been reported in Jersey, Calhoun, and Madison counties, Illinois, and Ralls and St. Charles counties, Missouri (personal communication, 1974, S. Vasse; Cruickshank 1966, 1967, 1970, and 1972; Arbib *et al*. 1973; Cruickshank and Manning 1968 and 1969).

King Rail <u>Rallus Elegans elegans</u> Audubon (Missouri)

This bird breeds in the continental United States east of central Nebraska and eastern Texas, excluding the northern regions of the northernmost states. Widmann (1907) considered this rail a common summer resident in Missouri. The destruction of marsh habitats through drainage and channelization has made the king rail increasingly rare (Missouri Dept. of Conservation and U. S. Dept. of Agriculture 1974).

Least Tern <u>Sterna albifrons athalassos</u> (Burleigh and Lowery) (Illinois, Missouri)

This tern breeds in the middle United States along the Colorado, Red, Missouri, and Mississippi river systems as far north as Nebraska and northeast Ohio to western Kansas and central Louisiana. Hardy (1957) reported it in Madison County, Illinois, on Mosenthien and Cabaret Islands in the Mississippi River. Hardy (1957) cited three factors influencing the occurrence and breeding of this subspecies: (1) they nest on sandbars, which are variable entities; (2) water levels must be favorable during the nesting season; and (3) shallow water must be available for foraging. Channelization and the building of dams, revetments, dikes,and pilings are detrimental to sandbar formation and, consequently, to nesting of least terns (Hardy 1957). Nesting habitat was located on many islands in the Mississippi River, but human disturbance has eliminated much of it. No nesting occurred in regular sites near East St. Louis, Madison County, Illinois, or other areas in the study area during 1974 (personal communication, 1974, V. Kleen, Non-Game Biologist, Illinois Dept. of Conservation, Springfield).

Long-eared Owl <u>Asio otus wilsonianus</u> (Lesson) (Illinois)

This owl breeds in the southern fourth of Canada east of Saskatchewan and in the continental United States, excluding Alaska, north of an area extending from Oklahoma to Virginia. It winters from eastern Canada to the gulf coast, and as far west as Texas. In Illinois, Ridgway (1889) found these birds most abundant in dense willow thickets. Such habitat is common along the Mississippi River and may provide nest sites if it is not flooded during the nesting season. Since 1965, the long-eared owl has been reported in Jersey and Calhoun counties, Illinois, during Christmas counts (personal communication, 1974, S. Vasse; Arbib <u>et al</u>. 1973).

Short-eared Owl <u>Asio flammeus flammeus</u> (Pontoppidan) (Illinois)

This owl breeds in the southern two-thirds of Canada, Alaska, and the northern half of the continental United States including the study area; it winters in the continental United States south of Canada. The short-eared owl nests on the ground in open sites close to water; plains, marshes, grassy meadows, and beaches where vegetative growth is low are favored nesting areas (Philipp 1920). In Missouri, Widmann (1907) did not consider this owl unusual to the marshes of the Mississippi River floodplain

north of the Missouri River; Anderson and Bauer (1968) regarded this owl as a casual resident during the summer and uncommon during the winter. This bird has been reported in Ralls and St. Charles counties, Missouri, in Christmas counts (Cruickshank 1967 and 1972), and was "generally up in numbers" during the 1967-1968 winter counts at St. Louis (Peterson 1968:444). In Illinois, population numbers decrease in frequency from north to south (Graber and Golden 1960).

Saw-whet Owl Aeglius acadicus acadicus (Gmelin) (Illinois)

This bird breeds in the southern third of Canada and the northern third of the continental United States south of Canada. It winters throughout the breeding range and the remainder of the continental United States, excluding areas south of a region extending from northern Texas to South Carolina (Robbins et al. 1966). Within the study area, it is a permanent resident and requires dense thickets and young evergreen plantations for cover (Robbins et al. 1966).

Yellow-bellied Sapsucker Sphyrapicus varius varius (Linnaeus) (Illinois)

The breeding range of this species includes the southern half of Canada and the area north of a line extending from Oregon through central Illinois and eastward to Connecticut (Robbins et al. 1966). It winters in the southern two-thirds of continental United States, including Missouri and the south half of Illinois. This bird is found in woods and orchards where it drills rings of holes in tree trunks to obtain sap and insects (Robbins et al. 1966). Since 1965, the yellow-bellied sapsucker has been recorded in Christmas bird counts in Jersey, Calhoun, and Madison counties, Illinois, and St. Charles and Ralls counties, Missouri (personal communication, 1974; S. Vasse, Cruickshank and Manning 1968 and 1969).

Brown Creeper Certhia familiaris americana (Bonaparte) (Illinois)

The brown creeper breeds in the southern fourth of Canada east of Alberta, the northern quarter of the continental United States, and Illinois (personal communication, 1974, V. Kleen), and possibly eastern Missouri. Greer (1966) reported nesting creepers near a levee on the Mark Twain National Wildlife Refuge; Widmann (1895) reported this bird from cypress swamps in southeastern Missouri. It winters in the southern third of Canada's southern provinces east of Alberta, and the eastern half of the United States. It was observed at the Norton Woods Public Access Area, Lincoln County, Missouri, in forest habitat on 25 July 1974. Since 1965, the brown creeper has been reported in Calhoun, Jersey, and Madison counties, Illinois, and St. Charles and Ralls counties, Missouri (personal communication, 1974, S. Vasse; Cruickshank 1966, 1970, 1971, and 1972; Arbib et al. 1973; Cruickshank and Manning 1968 and 1969).

Bewick's Wren Thryomanes bewickii bewickii (Audubon) (Illinois)

This subspecies breeds in the east-central half of the

United States east of Kansas, excluding the Atlantic seaboard; it winters in the southeast quarter of the United States, excluding the Atlantic seaboard. Bewick's wren is a summer resident in most of the study area, and a permanent resident in the south. This bird is an inhabitant of farmyards, brush, and fencerows (Robbins et al. 1966). An individual was observed in a brushy thicket near an abandoned farmyard at Pike County Conservation Area, Illinois, on 13 August 1974. This wren has been recorded in Christmas bird counts in Jersey and Calhoun counties, Illinois (personal communication, 1974, S. Vasse; Cruickshank 1972).

Loggerhead Shrike *Lanius ludovicianus migrans* (Palmer) (Illinois)

This shrike breeds in the United States and Canada south of an area extending from southern Manitoba to southwest New Brunswick, excluding most areas of coastal states from eastern Texas to Maryland. It winters in the southern half of its breeding range, which includes the southern half of the study area. The loggerhead shrike is regarded as uncommon in the St. Louis area (Anderson and Sauer 1968). Within Illinois, the breeding population has been largely extirpated north of an area extending from southern Pike to southern Cumberland counties (Graber et al. 1973). The decrease of hedgerows, used for nesting, has been postulated as a reason for the decline of this bird; decreased acreage in hayfields, with a high forage value, may be a more tenable reason for the decline, especially the rapid decline after 1957 (Graber et al.1973). Since 1965, it has been recorded in Jersey, Calhoun, and Madison counties, Illinois, and St. Charles and Ralls counties, Missouri (Personal communication, 1974, S. Vasse; Cruickshank 1966, 1967, and 1972; Arbib et al. 1973; Cruickshank and Manning 1968 and 1969).

Endangered Species

Double-crested Cormorant *Phalacrocorax auritus auritus* (Lesson) (Illinois, Missouri)

This cormorant breeds in the southern third of Canada east of central Alberta, and the continental United States, excluding Alaska, north of an area extending from northern Utah through Texas to northeast Maine. Palmer (1962) listed freshwater lakes, ponds, rivers, swamps, and sloughs as habitats frequented by this bird. Isolated and undisturbed swamps and islands are required for breeding. Since it feeds on fish, eels, crustaceans, and other large aquatic organisms which concentrate pesticides in their tissues, the wide use of DDT may be a factor in the cormorant's decline (George 1971). A colony of these birds was destroyed by commercial fishermen on the Illinois River as they believed the cormorants greatly reduced fish populations (Smith 1911). Cormorants nested on the Clarksville Refuge, Pike County, Missouri, in the mid-1960's (personal communication, 1974, A. Artus, Missouri Dept. of Conservation, Elsberry); in 1965, the colony had approximately 15 nests constructed in dead trees standing in a marsh. The birds returned to the area in 1966 and 1967 but did not nest. Cessation of nesting was believed to be caused by increased traffic

in the area associated with the construction of a cement plant and the lack of water at the nesting site. If the availability of nesting sites is a limiting factor of this cormorant, artificial snags may increase reproduction when appropriately placed. In recent years, the double-crested cormorant has been recorded only as a transient in the study area. These sightings occurred in Madison County, Illinois, in April 1972 (Kleen and Bush 1972); on the Mark Twain National Wildlife Refuge on 4 September 1970 and 24 October 1972; and in Lincoln County, Missouri, in October 1973 (personal communication, 1974, A. Artus).

Sharp-shinned Hawk Accipiter striatus velox (Wilson) (Illinois-Rare, Missouri)

This hawk breeds in the southern half of Canada and the continental United States, except in the southeastern quarter. It winters in the southern three-fourths of the United States as far west as Montana. Cory (1909) considered this bird a common transient but an uncommon summer resident in Illinois. This bird is rare as a breeder in Missouri and is usually seen only in migration periods (Missouri Dept. of Conservation and U. S. Dept. of Agriculture 1974). The sharp-shinned hawk occurs in open woodlands and wood margins where it feeds on small birds and rodents (Martin et al.1951). Farmers who believe the hawk preys on barnyard fowl and hunters who use the hawk for target practice have contributed to the decline of this raptor (Forbush 1920). Since 1965, it has been recorded during Christmas bird counts in Jersey, Calhoun, and Madison counties, Illinois (personal communication, 1974, S. Vasse; Cruickshank 1972).

Cooper's Hawk Accipiter cooperii (Bonaparte) (Illinois, Missouri)

The Cooper's hawk breeds in the southern fourth of Canada's southern provinces and all of the continental United States south of Canada; it winters in the southern three-fourths of the United States. Widmann (1907) considered this species a common summer resident in Illinois, where cultivated fields were adjacent to woodlands. It is considered less common than the sharp-shinned hawk in Missouri (Missouri Dept. of Conservation and U. S. Dept. of Agriculture 1974). During Christmas bird counts, the Cooper's hawk has been recorded in Jersey, Calhoun, and Madison counties, Illinois, and St. Charles and Ralls counties, Missouri (personal communication, 1974, S. Vasse; Cruickshank 1966 and 1971).

Red-shouldered Hawk Buteo lineatus lineatus (Gmelin) (Illinois, Missouri-Rare)

This hawk breeds south of an area extending from Nebraska to Maine (Robbins et al.1966). It winters south of an area extending from eastern Kansas through central Illinois to Massachusetts. The red-shouldered hawk is a resident of moist woodlands and cultivated fields (Robbins et al.1966), where it feeds on amphibians, reptiles, birds, and small mammals (Martin et al. 1951). Clearing of forest may have caused the decline of this hawk. Since 1965, this bird

has been recorded in Jersey, Calhoun, and Madison counties, Illinois, and in St. Charles County, Missouri (personal communication, 1974, S. Vasse; Crucickshank 1966 and 1972; Cruickshank and Manning 1968).

Osprey Pandion haliaetus carolinensis (Gmelin) (Illinois, Missouri)

This bird breeds from the arctic region southward. It has been recorded in the study area three times since 1964: in Calhoun county, Illinois, on 12 June 1970 (Peterson 1970) and in October 1971 (Fawks 1972) and in Pike County, Illinois, at Illinois River mile 57.7 on 16 September 1974 (personal communication, 1974, D. R. Parsons, Biologist, Waterways Experiment Station, Vicksburg, Mississippi). No recent nesting has been recorded in Missouri (Missouri Dept. of Conservation and U. S. Dept. of Agriculture 1974). George (1971) believed the decline of the piscivorous osprey may be linked with effects of DDT in the environment.

Bald Eagle Haliaetus leucocephalus alasanus (Townsend) (Missouri-Rare); H. l. leucocephalus (Linnaeus) (Illinois)

The breeding and wintering range of the southern bald eagle (H. l. Leucocephalus) lies south of the study area, but individuals wander north over the southern three-fourths of the continental United States. The northern bald eagle (H. l. alasanus) winters in its breeding range of Canada, excluding the northernmost regions; the northern fourth of continental United States; and Alaska. It migrates to and along major bodies of water. The northern subspecies winters in Missouri in fair numbers (Missouri Dept. of Conservation and U. S. Dept.of Agriculture 1974). The species distribution in Illinois is primarily restricted to floodplains of the Mississippi River, the Illinois River, and other large rivers (Graber and Golden 1960). The bald eagle is common in the area of Alton Dam near St. Louis (Anderson and Bauer 1968). It is primarily a scavenger and lives on dead fish and occasional waterfowl. The southern bald eagle is listed as endangered by the U. S. Fish and Wildlife Service (Office of Federal Register 1972). Shaw (1965) found this bird along bluffs in Calhoun, Jersey, and Madison counties, Illinois, on 30 January 1965. A population has been regularly observed at Pere Marquette State Park, Jersey and Calhoun counties, Illinois; the counts ranged from a low of 45 birds in 1971 to a high of 198 in 1968 (personal communication, 1974, S. Vasse). This eagle has also been recorded in Jersey and Madison counties, Illinois, and St. Charles and Ralls counties, Missouri, during Christmas bird counts (Cruickshank 1966, 1967, 1970, 1971, and 1972; Arbib et al. 1973; Cruickshank and Manning 1968 and 1969). The bald eagles that winter on the Mississippi River (Pools 24, 25, and 26) and on the lower Illinois River have been counted annually since 1965 (Table 5).

Upland Sandpiper Bartramia longicauda (Bechstein) (Illinois)

The upland sandpiper breeds from southern Alaska to central Maine southward to an area extending from eastern Oregon through northern Texas to Maryland. Ridgway (1889) considered this bird a common species in Illinois, where it was closely associated with prairie habitat. The population center of the upland sandpiper shifted from

northern to central Illinois (Graber and Graber 1963). Apparently, this shift was a result of the decreased acreage of prairie and pasture. A change in nesting habitat was also recorded; mixed hay and alfalfa were utilized instead of pasture.

Amphibians and Reptiles*

Rare Species

Dark-sided Salamander *Eurycea longicauda melanopleura* (Cope) (Illinois)

The range of this rare subspecies includes much of the eastern United States. In Illinois, it is recorded from the extreme southern counties and up the Mississippi River Valley north to Adams County. Specimens from Pike, Greene, and Madison counties might be expected to exhibit intergrade characteristics of the *longicauda* subspecies. Distribution in Missouri encompasses the southern counties, as well as a northern branch extending up the Mississippi River Valley. Generally an upland species, the dark-sided salamander is common in rocky streams, caves, and springs of the Mississippi River bluffs, and in the wooded uplands of Adams and Pike counties, Illinois.

Illinois Chorus Frog *Pseudacris streckeri illinoensis* Smith (Illinois, Missouri-Status Unknown)

Small, isolated populations of this frog occur in Arkansas, southeast Missouri, southeast Illinois, and six counties along the sand area of the Illinois River (Smith 1966). This rare subspecies was first recorded in Illinois by Smith in 1951 from a sand prairie area 3 miles north of Meredosia in Morgan County. Specimens were also recorded from a sand prairie in the Mississippi River floodplain in southeast Missouri (Smith 1955). Preferred habitat appears to be sand prairies; breeding habitat includes sloughs, flooded fields, ditches, and small ponds.

Illinois Mud Turtle *Kinosternon flavescens spooneri* Smith (Illinois)

The Illinois mud turtle is limited to a few isolated, remnant populations along the Mississippi River in northeastern Missouri and southeastern Iowa, in the sand prairie area along the Illinois River from Morgan to Peoria counties, and in Whiteside and Henderson counties. Preferred habitats of this rare turtle are backwater sloughs of the major rivers, and ponds in the sand prairies. Reduction of this relict xerothermic period turtle to a few remnant colonies is thought to be a result of climatic changes which have occurred in the Prairie Peninsula.

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*Unless otherwise cited, all information concerning nomenclature, distribution, range, and ecological requirements was taken from Conant (1958), Smith (1961), and Anderson (1965).

Mud Turtle <u>Kinosternon subrubrum subrubrum</u> (Lacepede) x <u>hippocrepis</u> (Gray) (Illinois)

The western mud turtle, which ranges from western Mississippi to the eastern half of Texas and north through southeast Oklahoma and Arkansas to Missouri, and the eastern mud turtle, ranging down the entire Atlantic coast to northern Florida, west to western Mississippi (including Georgia, Alabama, and Tennessee) and north into Illinois and Indiana, form an intergrade population in Illinois and possible in Missouri. Distribution of the mud turtle in Illinois includes the southern tip of the state and two isolated records from Calhoun and Peoria counties. The mud turtle is found in shallow water of roadside ditches, ponds, and bayous, associated with vegetative growth and, in some cases, in terrestrial habitats.

Slider <u>Pseudemys concinna hieroglyphica</u> (Holbrook) x <u>floridana hoyi</u> (Agassiz) (Illinois)

The slider, also called the hieroglyphic turtle, is a hybrid of the slider and the Missouri slider. The slider ranges in the Central Mississippi Valley from southern Indiana and Illinois through central Alabama, Mississippi, Louisiana, and extreme eastern Texas. The Missouri slider ranges from southern Missouri and southeastern Kansas to the coast of central Texas and east to Alabama. In Illinois, the rare hybrid occurs in the Mississippi, Wabash, and Ohio River Valleys to Calhoun County on the west and Lawrence County on the east. In Missouri, its distribution may range throughout the southeastern counties. In Illinois, at least, the hieroglyphic turtle appears to be restricted to the three large rivers and their adjacent lakes and sloughs.

Western Slender Glass Lizard <u>Ophisaurus attenuatus attenuatus</u> Cope (Illinois, Missouri)

This subspecies ranges west of the Mississippi River from southeastern Nebraska to eastern Texas, and east of the river into Illinois, western Indiana, and southern Wisconsin. Its range is presumed statewide in Missouri and Illinois. In the study area, specimens have been reported from St. Louis County, Missouri; from Jersey, Calhoun, Pike, Greene, and Scott counties in Illinois. This rare lizard is more common in the hills of Calhoun and Pike counties than elsewhere in Illinois. Specimens have been found in tall grass, a bottomland field, a forested hillside, and an open grassy area adjacent to woods. Due to its burrowing habits, this lizard may be more abundant than thought, although both Anderson (1965) and Smith (1961) termed it "rare" in Missouri and Illinois, respectively.

Western Worm Snake <u>Carphophis amoenus vermis</u> (Kennicot) (Illinois)

The range of the worm snake includes all of the southeastern United States except Florida. In Illinois, the western worm snake has been collected only from Calhoun, Adams, and Hancock counties. Intergrades of the western and midwest worm snake may be expected to occur at the confluence of the Illinois and Mississippi rivers. In Missouri, distribution is statewide, and specimens have been collected from the three southern counties of the study area. This snake is

commonly found in moist wooded situations under rocks and decaying logs.

Western Smooth Green Snake *Opheodrys vernalis blanchardi* Grobman (Missouri)

In the United States the range of this snake includes the Northern Great Plains and prairie region westward to the Black Hills, and the Rocky Mountains in Colorado, New Mexico, and Utah. In Missouri, specimens have only been collected north of the Missouri River; one specimen was taken in St. Charles County. In Illinois, distribution is sporadic in the northern counties. Although prairie habitats are preferred, this terrestrial snake has been reported from a variety of habitats including low bushes, grassy areas, wet meadows, timbered rocky hillsides, and vacant lots of suburban areas.

Eastern Massasauga Rattlesnake *Sistrurus catenatus catenatus* (Rafinesque) (Missouri)

The eastern massasauga ranges from central New York and Pennsylvania, through Ohio into Michigan, northern Indiana and Illinois, southern Wisconsin and Minnesota, and eastern Missouri north of the Missouri River. Collections from Mississippi River counties in Missouri include Lewis and St. Charles counties. Although once apparently common throughout the northern four-fifths of Illinois, it is now represented by widely scattered colonies. The massasauga prefers prairie marshes, old fields, and bogs; it has been recorded from dry woodlands. Drainage and cultivation of its preferred habitat types have been responsible for the decline of this snake.

Great Plains Rat Snake *Elaphe gutta emoryi* (Baird and Girard) (Illinois)

The range of this subspecies includes Central Mexico northward on the western side of the Rocky Mountains to southeastern Utah and adjacent portions of Colorado, and on the eastern side to southern Nebraska and Illinois. In Illinois, it occupies the five Mississippi River counties south of the confluence of the Illinois and Mississippi rivers; specimens have been collected from both the base and upper portion of the river bluffs in these counties. Its Missouri range includes most of the southern counties except for the extreme southeastern portion of the state. Rocky, timbered hillsides are the preferred habitat of this rat snake.

Endangered Species

Alligator Snapping Turtle *Macroclemys temmincki* (Troost) (Illinois, Missouri-Rare)

This turtle ranges from southeastern Georgia and northern Florida westward into south and central Texas, and east to the Mississippi River Valley. In Illinois, it is found in the Mississippi, lower Illinois, Ohio, and Wabash rivers and associated tributaries. Its Missouri distribution includes the southern two or three counties, the southeastern onefourth of the state, and the Mississippi River

to Lewis County. The alligator snapper is aquatic and sedentary, preferring muddy bottoms. Because of its reclusive habits, it is rarely recorded, although it is taken occasionally by commercial fishermen. Two specimens have been recorded from Calhoun and Jersey counties, Illinois.

Blanding's Turtle Emydoidea blandingi (Holbrook) (Missouri)

Blanding's turtle ranges through northeastern Nebraska, Iowa, Wisconsin, and Michigan, southward to northern Ohio, Indiana, and Illinois, and extreme northeastern Missouri. A disjunct population also occurs in Massachusetts and New Hampshire. In Missouri, this endangered species has been reported only from Clark County along the Mississippi River in the northeastern corner of the state. Its Illinois distribution includes much of the northern half of the state; generally, colonies are widely scattered except in the floodplain sloughs along the larger rivers. Collections have been made from the Illinois counties of Cass and Morgan. Decline of this turtle in Illinois is attributed to drainage of the extensive central prairie marshes.

Plains Hognose Snake Heterodon nasicus Baird and Girard (Illinois-Rare, Missouri)

The species, H. nasicus, exhibits a disjunct range with small relict populations occurring in northern and central Illinois and in extreme southeastern Missouri (Smith and Smith 1962). The plains hognose snake (H. n. nasicus), which occurs west from Minnesota to Alberta, Canada, and south to New Mexico, has been reported in Missouri only from Holt County. In Illinois, it is recorded from scattered sand prairies along the Mississippi River in Henderson, Mercer, Whiteside, and Lee counties. An intergrade population (H. n. nasicus x gloydi) of the plains hognose and the dusty hognose (H. n. gloydi) occurs in the sand prairie areas adjacent to the Illinois River; specimens of this intergrade population have been collected from Morgan and Cass counties. Sand prairies and adjacent woodlands provide suitable habitat for both subspecies, and in these limited areas, they appear to be fairly common in Illinois (personal communication, 1973, P. W. Smith, Illinois Natural History Survey). Similar to the Illinois mud turtle and the northern lined snake, the hognose snake is also represented by isolated Illinois populations which are remnants from a period of warmer, as well as more arid, conditions which prevailed at higher latitudes in the past (Smith and Smith 1962).

Northern Lined Snake Tropidoclonion lineatum lineatum (Hallowell) (Illinois)

The northern lined snake is found over most of Kansas, eastern Nebraska, extreme southeastern South Dakota, southern Iowa, northwestern Missouri, and central Illinois. The range in Missouri is discontinuous across the northern half; four collections from St. Louis County represent the only occurrence of this subspecies along the Mississippi River. In Illinois, its range is disjunct from other populations, occurring only in an isolated area in the central portion of the state. Smith (1953) suggested that distribution records in Illinois represent remnant colonies of a formerly widespread distri-

bution which occurred during a post-glacial warm, dry period. The lined snake is described as an urban species, found in vacant lots, under debris, and along the base of shrubs and fences where leaves have collected. It has also been found in sparse timber. Throughout much of its range, it is a fairly common species. Due to its small size (usually less than 1 foot) and semifossorial habits, it is readily overlooked. In the opinion of P. W. Smith (personal communication, 1973), it is not endangered in Illinois.

Timber Rattlesnake Crotalus horridus horridus Linnaeus (Illinois)

The distribution of the timber rattlesnake extends from New Hampshire to southern New Jersey; south in the Appalachian highlands to northern Alabama and west through the Ohio Valley; Minnesota and Wisconsin to northeastern Texas; and also northern Ohio. Except for the southeastern part of the state, it occurs throughout Missouri. Collections have been recorded from Clark, Pike, and St. Louis counties, Missouri, along the Mississippi River. In Illinois, it ranges throughout the southern one-third of the state, as well as along most of the Mississippi River Valley and in isolated areas along the Illinois River. The species is reported to be fairly common along the Mississippi River where rock outcrops are extensive. Collections were reported from Jersey, Greene, and Pike counties along the Illinois River. Preferred habitats of this subspecies include forested bluffs and rock outcrops, although they may also be found in cultivated fields, abandoned buildings, and brush piles. The decline of this snake is due in part to man's efforts to exterminate it from populated areas.

APPENDIX E

LETTERS RECEIVED BY THE DISTRICT ENGINEER ON THE DRAFT ENVIRONMENTAL STATEMENT

INDEX - APPENDIX E

INDEX - APPENDIX E (Cont'd)

UNITED STATES
ENVIRONMENTAL PROTECTION AGENCY
REGION V
230 SOUTH DEARBORN ST.
CHICAGO, ILLINOIS 60604

SEP 1975

Colonel Thorward R. Peterson
District Engineer
U. S. Army Engineer District, St. Louis
210 N. 12th Street
St. Louis, Missouri 63101

Dear Colonel Peterson:

In response to your letter of July 8, 1975, we have completed our review of the Draft Environmental Impact Statement (EIS) for the Operation and Maintenance of Pools 24, 25, and 26 Mississippi and Illinois Rivers. Our major environmental concerns are in regard to wetland encroachment, water quality impacts, dredging and disposal practices and the need for greater flexibility in the dredge spoil disposal program.

Our primary concern with dredging activities as described in our comments involves the placement and containment of dredge spoil and the potential effects upon aquatic and terrestrial environment. Past and current practices have had deleterious impacts along the Mississippi and Illinois Rivers and many of these practices could be corrected with acceptable alternative measures. The Congressional authorization for the 9-foot channel project allows sufficient flexibility to satisfy environmental concerns; therefore, environmentally sound alternatives to current disposal practices should be implemented.

We have classified our comments as Category ER-2. Specifically, this means we have environmental reservations concerning the effects of the maintenance program on water quality and wetlands. In addition, we believe additional information and studies are necessary to evaluate the environmental impacts of maintenance activities. The classification and the date of our comments will appear in the Federal Register in accordance with our responsibility to inform the public of our views on major Federal actions.

If you or your staff has any questions concerning the attached comments, please contact Mr. Gary A. Williams at 312-353-5756.

Sincerely yours,

Donald A. Wallgren

Donald A. Wallgren
Chief,
Federal Activities
Branch

Attachment:
As Stated

General Comments

To demonstrate how the O&M program outlined in the EIS has minimized adverse environmental impacts which resulted from past dredging practices, the final EIS should compare and contrast past operation and maintenance activities with the proposed O&M program discussed in the EIS. Differences in past dredge spoil disposal activities to the proposed disposal program should be indicated.

It is noted that some wetland areas will be affected by the project. EPA's Wetlands Policy states that wetlands must be protected from adverse dredging and filling practices. Therefore, extreme care must be taken during O&M activities to avoid and minimize any adverse impact upon wetlands. The Corps of Engineers policy regarding the safeguard of wetlands is highly desirable and consistent with our own views. With responsive and expedient implementation, such policy will substantially discourage the unnecessary alteration and destruction of wetlands considered to be vital to the riverine flowage. Although this policy is directed primarily toward the evaluation of permit applications, we fully realize the inherent responsibility of the Corps in following the dictates of its own policy and the guidance of EPA and other agencies in wetland preservation.

The EIS recognizes that the placement of dredged materials in critical areas (side channel exits or entrances) may have deleterious effects and that disposal in these areas is now avoided. The EIS should indicate how past practices have resulted in the placement of spoil in critical areas and discuss any measures that will be implemented to restore these areas particularly where side channels have been cutoff.

Spoil disposal, either on-shore or into the open water, constitutes the primary adverse environmental impact associated with the operation and maintenance of the navigation channel. In spite of its importance, however, the EIS does not contain a comprehensive spoil disposal plan.

Attributing a beneficial use of dredged spoil to provide wildlife habitat is not valid or reconcilable on a short-term basis. Furthermore, it doesn't take into consideration the loss of one type of habitat for another. The EIS indicates that in many cases natural revegetation of spoil areas has not occurred because of repeated deposits of spoil. Also, where woodlands have been subjected to disposal but not with sufficient frequency to cause mortality, the trees have been partially killed or stunted and the understory has been lost. Usually diverse aquatic or terrestrial habitat are converted into sterile sand-shoals and piles providing a poor substrate.

Although some data is provided, the EIS is lacking an adequate description of the dredge spoil. A complete sediment analysis and characterization would facilitate prudent selection of spoil sites and would also serve as a basis for determining the usefulness of spoil in recreation areas and the prospects for revegetation of spoil sites. Omitted is any reference to a definite time span in which revegetation may occur.

The final EIS should identify the areas considered as "on or near the banks". If these spoil locations include backwaters, marshes, sloughs and areas behind wing dams, the deposition would result in a significant impact upon the biological stability of the river system. Although the impact of the spoil deposition at any particular site is not completely irreversible, in general, sites covered to any measurable extent cannot revert to their original state for extremely long periods of time. Repeated spoiling serves only to aggravate this condition, resulting in relatively permanent changes in flora and fauna.

The EIS fails to identify what varieties of wildlife can be supported on nearly sterile sand piles. In addition, the dynamic nature of flood plain habitats precludes the formation of large areas of uniform habitat types. Therefore, the diversity of an area is decreased through spoiling rather than increased as suggested.

The EIS fails to discuss dredging operation and spoil disposal with regard to impacts on the Federal and State managed wildlife refuges on or along the inland waterway systems. Specifically, information is not provided on regulations or assessments made on spoil deposition on or near these protected areas to evaluate potential environmental impacts caused by operation and maintenance procedures. Also, the relationship of pool regulation to the management of these areas and recommendations made by management agencies should be discussed. Recreational developments such as docks and concessions are referred to in the EIS as minor in magnitude. The maintenance of docks however may require periodic dredging. The EIS should discuss the dredging, disposal of spoil and associated environmental impacts relating to the maintenance of adequate depths for those activities related to private dredging.

The EIS should describe how the town of Grafton has been troubled in recent years by deposition in five small tributary streams. This discussion should address why the problem is of recent nature and what upstream improvements could be utilized to minimize the sedimentation.

It is stated in the EIS (p. 172), "Increasing the height of a low dike field can be effective in producing a dependable navigation channel if the dikes are not too short in relation to the river width. In the study area, there are no new dikes planned." This discussion indicates the effectiveness of increasing the height of a low dike field and mentions that no new dikes are planned; however, the discussion implies that the heights of low dike fields may be increased. The EIS should discuss any plans or proposals to raise low dike fields.

According to the EIS, much progress has been made in eliminating excessive amounts of timber clearing and bank grading in the navigation pools. This discussion should be expanded. The problems experienced with timber clearing and bank grading in the past should be described and the progress that has been made in eliminating these problems should be explained in more detail.

According to the EIS, there has been a net deposition of sediment in Peasa, Elsah, and Chautauqua Creeks in Illinois since the bridges were constructed, and that the State highway departments frequently clear sediment from the channels tributary to both the Mississippi and Illinois Rivers. This discussion should be expanded to address the disposal practices, environmental impacts and the relationship of this activity to Section 404 of the Federal Water Pollution Control Act Amendments of 1972.

Water Quality Impacts

As indicated in the EIS, one of the principal effects on water quality is the increase in turbidity caused by dredged churnings and spoil disposal. However, associated with this release of material one can usually find a decrease in available oxygen, increased conductivity, increased phosphates, additional total nitrogen and any other pollutant contained in the spoil. A study of dredging effect on water quality in pool #8 during the summer of 1973 indicated significant changes did occur in turbidity, nitrate and nitrogen. Also, a substantial decrease in dissolved oxygen was observed. Measures to minimize these adverse impacts can be utilized with limited treatment of the returning overflow, i.e., by the use of dikes, successive settling or retention basins. Selective monitoring for changes in water quality in areas of spoil disposal should be initiated whenever maintenance activities have the potential to adversely effect water quality, particularly in the vicinity of recreational areas and eco-sensitive wetlands such as spawning grounds or waterfowl habitats. Whenever State water quality standards are violated, the implementation of appropriate pollution abatement measures will be required as per Sec. 313 of PL 92-500.

Since pesticides, metals, sulfides, methane, oil and grease, ammonia and other substances, if present in the bottom sediments, can be released into the water column by resuspension of the sediment or from disposal areas, the locations of water intakes should be identified and measures to avoid degradation nearby water supply intakes should be described.

Water quality as well as aesthetics of some pools in the Upper Mississippi River would seemingly have a bearing on the demand for beaches. The potential health risks of providing beach areas which induce water contact recreation such as swimming, wading, or water skiing must be carefully studied with regard to water quality and applicable water quality standards. Where water quality is poor and not suited or safe for whole body contact, the development of beaches for recreation should be discouraged.

It is difficult to make an objective assessment of water quality problems using the minimal amount of information provided in the EIS. In addition, no data is presented assessing the adverse impacts of the actual dredging and spoiling operations. An adequate description of the dredge spoil should be provided for major areas of dredging as soon as practicable. Adequate analysis and characterization of the sediments would insure compliance with our acceptability criteria for spoil disposal, facilitate proper selection of spoil sites and also serve as a basis for determining the acceptability and usefullness of the spoil. Although some data was presented in the EIS, it is not clear if the data is representative of [illegible]

Section 1.6 of the EIS should include a discussion of the GREAT I and GREAT II Studies which are now being conducted in the St. Paul and Rock Island District reaches of the river. This river management study is a direct result of the concern over severe environemntal damages resulting from the past practices utilized by the Corps. The GREAT Study for the St. Paul District has been functioning for nearly one year and has developed numerous new ideas for correcting current environmental abuses. The GREAT is considering both short and long range problems and their solutions and can be applied in general to the St. Louis District. The GREAT II study is still in the early stages of development and will follow the precedent set by GREAT I and the overall objectives developed by the Dredge Spoil Disposal Practices Committee for the entire Upper Mississippi River. GREAT III is anticipated for the St. Louis District in the future. We urge full support by the St. Louis District COE in this effort.

In addition to the information requested above regarding water quality, we believe the following detailed long-range studies should be initiated to determine measures to substantially reduce the adverse effects associated with future operation and maintenance activities on the river. Such studies should include:

1) a comprehensive bottom sediment analysis of the river;

2) the short and long range effects of O&M activities upon water quality;

3) a qualitative and quantitive description of the wetlands, back-water areas, and woodlands impacted by O&M activities;

4) the general environmental effects of dredging sloughs and back-water areas;

5) the dynamics of sediment movement induced by dredging and disposal activities, and

6) a comparison of the overall effects associated with disposing the spoil within the lower limits of the flood plain to disposing of the spoil outside the floodway.

Alternatives

The evaluation of alternatives to the project is incomplete. Only two major alternatives to the existing operation and maintenance procedures are presented: discontinue operation of the locks and dams, and discontinue maintenance of the navigation channel. The other alternatives discussed are only modifications of the present dredging and spoil deposition techniques.

The alternatives of increased spoil disposal flexibility, revegetation of disposal sites, commercial use of dredge spoils, watershed land-treatment and development of recreational facilities have great potential in reducing adverse social, environmental and economic impacts. These alternatives should be incorporated whenever possible in maintenance dredging practices to alleviate adverse impact and should receive full consideration in your agency's decision-making process. Not in every case should only one method be used. Instead, all or a composite of these alternatives should be considered now and during future studies to determine their maximum environmental and economic public benefit. Revegetation of dredge spoils also appears to be a very viable alternative. It is recommended that future studies be undertaken to determine the feasibility of this alternative. A major environmental problem as stated in the EIS is the movement of dredge spoils by erosion. This alternative has great potential for partially correcting this problem in an effective way, environmentally and economically.

Consideration should be given to potential markets for spoil and the benefits to be derived from removal of the spoil from the river area. Included in this discussion should be a comparison of the long-term costs (especially environmental costs) of remote or central spoil disposal and the costs of the maintenance and operation program as it is practiced today.

Watershed land treatment should be considered for the tributaries that are known to be conveying extensive sediment loads to the Mississippi River. Attacking some of the causes of the sedimentation problem instead of its effects should substantially reduce dredging impacts and also have positive impacts upon both tributary streams and the Mississippi River. The use of spoil material for landfill or other purposes should be completely addressed as an alternative to present practices including an evaluation of economics vs. environmental costs.

The discussion of alternatives mentions that a discontinuation of the waterway service would force the utilization of other costlier modes of transportation. This statement may be true, however, since transportation rates are regulated by the Federal government, these rates are subject to change. In addition, Federal subsidy to particular carriers nessarilyabsorbs a portion of the full cost of the operation by the carrier. The EIS should compare the costs and the rates of various transportation modes with and without existing rate regulations and subsidies. The National Water Commission Report discusses the major issues relating to the development of water resources. One of the recommendations of the Report concerns user fees for navigation interests. This recommendation should be discussed as an alternative in the EIS.

The final EIS should also evaluate and compare the environmental impacts of the alternatives to waterborn transportation. These should include but not be limited to movement by rail, truck or pipelines or a combination of these modes with any other mode including barging.

Long-Term Effects

The EIS does not evaluate the long-term effects of spoil disposal on recreation. The continuous deposition of spoil on recreation areas must eventually reduce the suitability of the sites for recreation and either new spoil disposal

sites will have to be selected or recreation activities will be eliminated. These long-term impacts of spoil disposal upon recreation areas should be addressed in the final EIS.

All of the impoundments are characterized by a gradual process of sedimentation or filling particularly in areas outside the navigation channel. The operation and maintenance program for the 9-foot channel accelerates the rate of deposition in these areas by decreasing water velocities in backwater areas, direct spoil disposal, spoil disposal which impedes flows leading into or out of backwater areas, and spoil disposal which returns to the river. The EIS should acknowledge this gradual sedimentation process with regard to long-term impacts and discuss them in detail. An attempt should be made to predict the changes in physical and biological characteristics of the Upper Mississippi River through the next 100 years and beyond assuming existing maintenance activity continues. Long-term effects should take into consideration not only the consequences upon flood plain and lowland uses, wetlands, bottomland forest, sloughs, and backwater areas, but also the constriction of the existing meandering waterway, development of a uniform navigation channel and sedimentation and deposition in each pool.

The EIS provides a generous amount of information on the "beneficial" effects of the impoundments upon recreation, fish and wildlife. The final statement should predict the long-term effects, both beneficial and adverse, upon recreation, fish and wildlife resulting from the maintenance of the 9-foot navigation channel. It appears that the long-term benefits of the present maintenance program favor commercial navigation at the expense of recreational; fish and wildlife uses. More emphasis should be placed on enhancement and maintenance of the value of the river for uses other than commercial navigation.

The EIS does not discuss the effects of dredging and spoil disposal upon the hydraulic characteristics of the Mississippi River. Natural sedimentation behind the wing dams combined with spoil disposition in the off-channel areas continues to constrict the river channel. This reduction in channel capacity may affect the river stages, particularly the flood stages. Higher flood stages would result in the need to raise the levee systems downstream and modifications of the levees could have a significant impact upon the river and riparian environments. Consequently, we believe the EIS should contain a discussion of the effects of channel construction upon the river stages and the primary and secondary impacts of any changes in the river stages upon the Mississippi River system.

Recommendations

In conclusion, we believe the following general approach should be used in relating to the environmental impacts of O&M activities on the Upper Mississippi River. This approach will designate EPA's general recommendations regarding dredging and spoil disposal in the Upper Mississippi River.

1. The need for greater flexibility in the handling and disposal of dredged spoil is required because of the adverse impacts upon environmentally sensitive areas. Additional expenditures for longer pipelines, booster and pump-out

equipment and transport barge may be necessary to increase the flexibility of O&M activities.

2. The practice of retaining spoil in and adjacent to the waterway should be modified. The adverse effects of the existing program upon water resources and wetlands are apparent. Where feasible, we believe spoil should be moved as far away from the river as practicable to prevent its redeposition in the river. This approach will not be necessary in every case, but where shoaling is intense and dredging requirements are extensive, it should be encouraged. Furthermore, if sensitive wetlands or bottomland forests exist in the vicinity, spoil should also be removed to a more compatible area, preferably outside the floodway. Placement in fringes of the flood plain would probably be acceptable.

3. The existing program of selecting spoil disposal sites is in need of modification. Regardless of the fact the infrequent spoilage in some areas has created a few diversified ecosystems, the usual results are sterile sand-shoals that either directly impinge upon or indirectly through sedimentation and redeposition adversely impact environmentally sensitive areas such as spawning and fishing grounds, waterfowl habitat, and other wetland or bottomland habitats. With care and coordinated agency planning, this kind of impact can be avoided.

4. The load capacity of a given area to successfully retain spoil deposits and support a viable ecosystem is an important factor that has been overlooked in the past and should be given careful study in the future. When selecting sites for disposal, consideration should be given to the frequency of spoil disposal, the quantity of spoil, and the type of area affected.

5. Bottom sediments of each pool should be periodically monitored (3-year intervals) to determine their quality and character for a compatible program of disposal with local ecosystems. Bottom sediments that are found to be polluted must be confined in a disposal facility.

6. Where necessary, pollution abatement structures for given disposal areas should be constructed and completed prior to the disposal of spoil. Stabilization of the disposal area is an important measure that should be implemented after spoil deposition. Stabilization measures such as revegetation and erosion control are necessary to minimize water and wind erosion and redeposition in the river.

7. In order to improve the understanding of O&M activities on the Upper Mississippi River, studies to determine the composition of bottom sediments, short and long range water quality effects, the nature of sensitive areas, effects of dredging backwaters, the nature of sediment movement and effects of spoil placement should be undertaken as soon as practicable.

8. Recommendations proposed by the Upper Mississippi River Conservation Commission in their 1969 Upper Mississippi River Dredge Spoil Survey should be considered as alternatives to present dredging activities. Basically the

Commission recommended an evaluation of current deposition practices in order to detect and eliminate environmentally harmful practices. Several excellent recommendations for selection of future spoil sites as discussed in the survey. Adherence to these recommendations will aid in elimination of damages resulting from maintenance and operation of the 9-foot channel.

9. The disposal of dredged material shall be consistent with the EPA Section 404 Guidelines for Discharge of Dredged or Fill Material (Federal Register dated September 5, 1975).

United States Department of the Interior

OFFICE OF THE SECRETARY
NORTH CENTRAL REGION
230 S. DEARBORN STREET, 32nd FLOOR
CHICAGO, ILLINOIS 60604

(ER-75/675)

August 29, 1975

Colonel Thorwald R. Peterson
District Engineer
U. S. Army Engineer District
St. Louis
210 North 12th Street
St. Louis, Missouri 63101

Dear Colonel Peterson:

The Department of the Interior has reviewed the Draft Environmental Statement for the Operation and Maintenance of Pools 24, 25, and 26, Mississippi and Illinois Rivers, Missouri and Illinois, as requested in Mr. [illegible]'s transmittal letter of July 7, 1975, to our Assistant Secretary, Program Development and Budget. Our comments which are of both a general and specific nature relate to areas of our jurisdiction and expertise and have been prepared in accordance with the National Environmental Policy Act of 1969.

GENERAL: This document de-emphasizes the causes and effects of side-channel sedimentation. The effect of dikes and revetment in preventing the formation of the new side channels is not mentioned, which thus gives a misleading picture of project effects. Also, because of incomplete information, it is not possible to evaluate project effects on the mussels of the Illinois and Mississippi Rivers.

SPECIFIC: Part I - PROJECT DESCRIPTION - Figures 1-4 and 1-6 - Are the proposed recreation areas to be developed by the Corps of Engineers?

Page 20 - To avoid misunderstanding, the fourth paragraph should indicate that it has been standard procedure to over dredge to a depth of 11 or 13 feet below minimum pool elevation.

Page 23 - 1.6.2.2 State of Illinois Recreation Plan - A more recent State comprehensive outdoor recreation plan, Illinois Outdoor Recreation, prepared by the Illinois Department of Conservation, was released in December 1974.

AMERICAN REVOLUTION BICENTENNIAL 1776-1976

Part 2 - EXISTING ENVIRONMENTAL SETTING

Page 85-d. Benthos - The treatment of mussels in this section is inadequate. Several common species were not recorded, including: Anodonta grandis, Arcidens confragosus, Lampsilis anodontoides, Fusconaia flava, and Proptera laevissima. No mention is made of the commercial value of mussels, even though in 1966 there were 36 commercially fished mussel beds on the lower 80 miles of the Illinois River. The location and abundance of mussels is especially important in evaluating project effects since they are benthic organisms easily disturbed by dredging and spoil disposal.

Page 122 - Several species of mussels listed by Missouri as rare or endangered are known to occur in the Upper Mississippi River. These include: Arcidens confragosus, Obovaria olivaria and Quadrula nodulata.

Page 143 - 2.5 OUTDOOR RECREATION - It would be helpful if the major recreation areas and parks were shown on a map.

Part 4 - IMPACT OF THE ACTION ON THE ENVIRONMENT

Page 169 - 4.1.2.2 Dredging and Disposal - Coordination of dredge spoil placement with conservation agencies does not always ensure that no adverse impact will occur. The penultimate paragraph also should state that frequently, because of cost and equipment limitations, spoil is not placed in the locations preferred by the conservation agencies.

Page 180-b. Revetments - Although revetment may contribute to aquatic habitat diversity to some small degree, it also effectively prevents the formation of any new side channels or off-channel lakes. As such, revetment cannot be considered beneficial to the aquatic communities.

Page 183 - Overbank Dredged Materials - The effects of spoil disposal on terrestrial vegetation is understated. The term 'important species" should be defined or deleted. Frequently, spoil material is biologically sterile and years are required for even a sparse vegetative cover to reestablish itself on a disposal site. This lack of vegetation not only destroys the wildlife habitat value of the area, but also causes the spoil to be easily eroded back into the river.

Page 184-b. Maintenance Dredging and Placement of Dredged Material - Spoil material placed in the river may provide resting and loafing habitat for certain birds; however, there is a complete loss of aquatic habitat under these circumstances.

Page 185 - IMPACT ON THREATENED, RARE OR ENDANGERED SPECIES - The silting in of sloughs and side channels does not create habitat diversity,

as indicated in the second paragraph under this heading; rather, such silting reduces habitat diversity.

The least tern is the only rare or endangered bird breeding in the study area that requires sandbanks for nesting. Even for this species, there have been no recent breeding records in the study area.

Page 188 - 4.5 IMPACT ON OUTDOOR RECREATION - This section requires more discussion. It is unclear why the project "will have no impact on existing recreational resources or use of the sites" but "recreation on the Upper Mississippi and Lower Illinois Rivers proper . . . will suffer adverse effects." Specific adverse impacts have not been enumerated. Impacts from dredging such as turbidity and spoil disposal sites should be discussed. Possible enhancement to recreational navigation and beach nourishment also should be treated. Adverse impacts also should be enumerated in Part 5.

Page 188 - 4.6.1 ARCHEOLOGY - It is encouraging to note that a comprehensive shoreline archeological survey is currently under way along the lower Illinois River. We hope that the results of this survey will be presented in the final statement. Also, we suggest that such a survey be conducted of the shoreline of pools 24, 25, and 26 in order to insure that future recreational developments, industrial development, or any number of water-related land uses do not adversely affect significant historical and archeological values. The statement should present procedures to be implemented in the event that previously unknown cultural resources are encountered during project construction.

Page 189 - 4.6.2 HISTORY - We suggest that the determination that no historic sites will be disturbed by operation and maintenance activities reflect consultation with the State Historic Preservation Officers for Missouri and Illinois.

Part 6 - ALTERNATIVES TO THE ACTION

The alternative of providing the 9-foot channel depth for only a portion of the navigation season should be considered. It is possible that a significant amount of environmental damage could be avoided by allowing the navigation channel to be less than 9-feet deep for a small portion of the year.

Page 200 - 6.2.3 RECREATIONAL POTENTIAL - A qualified statement should be substituted for the first sentence of the third full paragraph on this page. The effect on the aquatic community of using dredge spoil to develop recreational areas will vary depending on the site.

Page 202 - Twenty-five percent plant cover in 5 years is not "fairly rapid" revegetation. Within the study area, normally fertile soil has nearly 100 percent plant cover within 1 year after being disturbed.

Page 203 - 6.2.7 REMOVAL FROM FLOOD PLAIN - The term "effective biological life" should be defined. The removal of dredge spoil from flood plain could significantly reduce the rate of sedimentation in backwater areas.

Part 7- THE RELATIONSHIP BETWEEN LOCAL SHORT-TERM USES OF MAN'S ENVIRONMENT AND THE MAINTENANCE AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY

Page 207 - It should be mentioned that control of the river through dikes and revetment prevents any new side channels from forming. Under natural river conditions the side channels that are filled by sedimentation would be replaced by newly-formed side channels.

Part 9 - COORDINATION WITH OTHERS

Page 211 - We are pleased to see that a post-authorization change to include fish and wildlife conservation as a project purpose is being considered for the pooled section of the Mississippi River.

APPENDIX C

Table 46 - A more recent list of Rare and Endangered Vertebrates of Illinois was published in 1973 by the Illinois Nature Preserves Commission.

Page D-11 - Reference is made to an Appendix F that is not included in the document.

Sincerely yours,

Madonna F. McGrath

Madonna F. McGrath
Acting Special Assistant
to the Secretary

UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE
NORTHEASTERN AREA, STATE AND PRIVATE FORESTRY
6816 MARKET STREET, UPPER DARBY, PA. 19082
(215) 596-1672

8400
August 20, 1975

Jack R. Niemi, Chief
Engineering Division
Department of the Army
St. Louis District, Corps of Engineers
210 North 12th Street
St. Louis, Missouri 63101

Refer to: LMSED, Draft
Environmental Statement,
Pools 24-25-26, Mississippi
and Illinois Rivers, MO

Dear Mr. Niemi:

Our Milwaukee office referred the above statement, on operation and maintenance of navigation channels and structures, to us as no National Forest lands are affected directly.

Continued maintenance of the same channel will eventually result in drying up of wetlands that are associated with the changing channels of a meandering stream. On wildlife habitat the effect of "fixing" the channel should be discussed more fully. The final statement should also attempt to quantify the amounts of marsh and other habitat gained and lost by the effects of pool regulation.

Increased use of vegetation, including trees and shrubs, should be considered for stablizing dredge spoils on and near streambanks. Under appropriate conditions such vegetation will reduce redeposition of sediment into the channel and lengthen the time between dredging projects.

Thank you for the opportunity to review this statement.

Sincerely,

D.O. Vandenburg

DALE O. VANDENBURG
Staff Director
Environmental Quality Evaluation

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
P.O. Box 459, Columbia, Missouri 65201

August 20, 1975

Mr. Jack R. Niemi
Chief, Engineering Division
U.S. Army Corps of Engineers
210 North 12th Street
St. Louis, Missouri 63101

Dear Mr. Niemi:

The draft environmental impact statement for Operation and Maintenance of Pools 24, 25, and 26, Mississippi and Illinois Rivers, has been reviewed by this office.

The statement would be strengthened by the addition of the plans for erosion control where stockpiling or overbank placement is a possible alternate. It is important that stockpile sites be chosen avoiding impacts to soils which have high value for agriculture. This office will provide assistance for erosion control and identification of important agricultural land where possible.

The operating levels of pools are important. Many conservation measures--particularly drainage--could be affected. Outlets have been, and will continue to be, designed based on the anticipated pool elevations maintained by locks and dams. Any changes in the elevations could affect these outlets.

We appreciate the opportunity to review and comment on this supplement.

Sincerely,

J. Vernon Martin

J. Vernon Martin
State Conservationist

UNITED STATES DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE

P.O. Box 678, Champaign, Illinois 61820

September 4, 1975

Mr. Jack R. Niemi
Chief, Engineering Division
U. S. Army Corps of Engineers
210 North 12th Street
St. Louis, Missouri 63101

Dear Mr. Niemi:

The draft environmental impact statement for Operation and Maintenance of Pools 24, 25 and 26, Mississippi and Illinois Rivers, dated June 1975, has been reviewed by this office.

On page 210, line 7 - suggest the word "Service" be deleted to make it read correctly.

The statement would be strengthened by the addition of the plans for erosion control where stockpiling or overbank placement is a possible alternate. It is important that stockpile sites be selected which would avoid adverse impact to soils which have high value for agriculture. This office will provide assistance for erosion control and identification of important agricultural land where possible.

The operating levels of pools are an important concern to agriculture. Many conservation practices, particularly drainage, could be adversely affected. Outlets have been, and will continue to be, designed based on the anticipated pool elevations maintained by locks and dams. Any changes in elevations could affect these outlets.

We appreciate the opportunity to review and comment on this project. Thanks for the extension of time in which to comment.

Sincerely,

Daniel E. Holmes

Daniel E. Holmes
State Conservationist

FEDERAL POWER COMMISSION
WASHINGTON, D.C. 20426

IN REPLY REFER TO:

AUG 13 1975

Mr. Jack R. Niemi
Chief, Engineering Division
St. Louis District, Corps of Engineers
Department of the Army
210 North 12th Street
St. Louis, Missouri 63101

Reference: LMSED-BA

Dear Mr. Niemi:

This is in reply to your letter of July 7, 1975, addressed to the Commission's Advisor on Environmental Quality, inviting comments on the draft environmental statement for the Operation and Maintenance of Pools 24, 25, and 26, Mississippi and Illinois Rivers. The draft statement discusses the continued operation and maintenance of these existing navigation facilities which are located in the States of Missouri and Illinois upstream of St. Louis, Missouri.

These comments of the Federal Power Commission's Bureau of Power are made in accordance with the National Environmental Policy Act of 1969 and the August 1, 1973, Guidelines of the Council on Environmental Quality. Our principal concern with activities affecting land and water resources is the possible effect of such activities on bulk electric power facilities, including potential hydroelectric developments, and on natural gas pipeline facilities.

The staff notes that the three projects discussed in the draft statement are integral elements of the 9-foot navigation channel project on the Mississippi River from the mouth of the Missouri River upstream to Minneapolis. A number of fossil-fueled power plants located along this

AMERICAN REVOLUTION BICENTENNIAL 1776-1976

navigation waterway utilize fuels transported via the waterway. Thus, continued maintenance of the waterway to provide the fuels essential to the operation of these power plants can contribute to assurance of the adequacy and reliability of electric power supplies in this mid-continent area.

The staff also notes that the steam-electric power plants depend on the navigation waterway as the source of cooling water supply. Care should be taken to protect cooling water intake and discharge structures which are located in the segment of waterway occupied by Pools 24, 25, and 26 from maintenance activities of dredging and dredged material disposal.

The opportunity to comment on the draft environmental statement is appreciated.

Very truly yours,

T. A. Phillips
T. A. Phillips
Chief, Bureau of Power

DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
REGION VII
FEDERAL BUILDING
601 EAST 12TH STREET
KANSAS CITY, MISSOURI 64106

OFFICE OF
THE REGIONAL DIRECTOR

September 2, 1975

Mr. Jack R. Niemi
Chief, Engineering Division
Department of the Army
St. Louis District,
Corps of Engineers
210 North 12th Street
St. Louis, Missouri 63101

RE: Draft Environmental Impact Statement
Operation and Maintenance - Pools 24, 25, and 26
Mississippi and Illinois Rivers

Dear Mr. Niemi:

Thank you for the opportunity to review the Draft Environmental Impact Statement covering the above referenced project.

We find that the project will have no impact upon programs of the Department of Health, Education and Welfare.

Sincerely,

William H. Henderson

William H. Henderson
Regional Environmental
Officer

DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT
CHICAGO AREA OFFICE
17 NORTH DEARBORN STREET
CHICAGO, ILLINOIS 60602

REGION V
100 South Wacker Drive
Chicago, Illinois 60606

August 26, 1975

IN REPLY REFER TO:
5.2SD (Goldfarb)

U. S. Army Engineer District
210 North 12th Street
St. Louis, Missouri 63101

Gentlemen:

Subject: Review of Draft EIS: Operation & Maintenance/ Pools 24, 25, & 26/Mississippi & Illinois Rivers

Your EIS carefully documented the importance of maintaining a nine foot navigation channel in this strategic section of the Mississippi River and the complex interrelationship between the maintenance of this channel and the quality of aquatic and terrestrial habitats.

Your information indicates that although most of the Corps' activities present limited viable alternatives the dredging action presents a real choice to decision makers. The EIS presents a choice of economic cost vs. aesthetic benefit. Since the Mississippi is a unique part of our cultural heritage it seems as if the increased cost, although significant (35% more for Kennedy & 66% more for Ste. Genevieve), is not prohibitive and might be warranted. The Corps' statement has served a useful purpose in delineating the scope of this choice.

Thank you for the opportunity to comment on this EIS.

Sincerely,

John L. Waner
Director
Chicago Area Office

DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT
FEDERAL BUILDING, 911 WALNUT STREET
KANSAS CITY, MISSOURI 64106

REGION VII

July 15, 1975

IN REPLY REFER TO:
7CE

Mr. Jack R. Niemi
Chief, Engineering Division
Department of the Army
210 North 12th Street
St. Louis, Missouri 63101

Dear Mr. Niemi:

This is to acknowledge receipt of your Draft Environmental Impact Statement for the Operation and Maintenance of Pools 24, 25, and 26, Mississippi and Illinois Rivers, dated June 1975.

HUD programs for the area in which the project is located are administered by Johnny Bullock, Jr., Director, St. Louis Area Office. By copy of this letter, Mr. Bullock is requested to review the draft statement and forward his comments directly to you no later than September 2, 1975, as indicated in your request.

Thank you for the opportunity to comment on this statement.

Sincerely,

Harry B. Bearman
Environmental and Standards Officer
Community Planning and Development

DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT
AREA OFFICE
210 NORTH 12TH. STREET, ST. LOUIS, MISSOURI 63101

AREA OFFICES
Kansas City, Kansas
Omaha, Nebraska
St. Louis, Missouri

REGION VII
REGIONAL OFFICE
KANSAS CITY, MISSOURI

SEP 02 1975

IN REPLY REFER TO
7.3P

Mr. Jack R. Niemi
Chief, Engineering Division
Department of the Army
Corps of Engineers
210 North 12th Street
St. Louis, Missouri 63101

Dear Mr. Niemi:

Reference is made to your letter of July 17, 1975, requesting comments on the Draft Environmental Impact Statement for the Operation and Maintenance of Pools 24, 25 and 26, Mississippi and Illinois Rivers. Your letter and Draft Statement have been forwarded to this Area Office for review and comments.

From the information contained in the draft statement, it does not appear that there are any conflicts with the plans or programs of this HUD Area Office. We do, however, offer several suggestions.

First of all, one of your overall alternatives is to do nothing, open all the dam gates and let both rivers seek their own levels. It should be noted that Federal law including various River and Harbor Acts will not permit this. In fact, there is a specific law prohibiting the Corps from making any change in the levels of these rivers.

Criteria used to select dredge disposal sites should be clearly discussed and included in the statement. Consideration for erosion protection or containment should be explained.

Actually, there is both an energy and inflationary impact to consider in the draft statement. The recent energy shortage is a powerful incentive for reassessing our environmental project impacts. Therefore, the following evaluations should also be discussed and questioned.

1. Are there potential problems with the supply of energy required to operate and maintain Pools 24, 25 and 26?

2. Will the Operation and Maintenance consume excessive amounts of energy?

3. Will energy conservation technology be employed?

We trust that continued study and research will be spent on the fabric of interrelations among all living things in and along the Mississippi and Illinois Rivers, both qualitativey and quantitively. To deal with and respect both rivers, it will not be enough to predict which way things will change; there will be a definite need to know how much change and for what reasons.

When completing an environmental review one basic question always remains. How will the statement be used? Hopefully, this environmental statement will not only shape existing but the future projects so all development plans and proposals will be responsive to the environmental problems and concerns of the people most directly affected.

Thank you for giving us the opportunity to provide these comments. We would appreciate receiving a copy of the final statements.

Sincerely,

for Jerry J. Bauer

Johnny Bullock, Jr.
Acting Area Director

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
REGION 5
18209 DIXIE HIGHWAY
HOMEWOOD, ILLINOIS 60430

July 23, 1975

IN REPLY REFER TO 05-00.5

Mr. Jack R. Niemi
Chief, Engineering Division
U.S. Army Engineer District
210 North 12th Street
St. Louis, Missouri 63101

Dear Mr. Niemi:

As requested, we have reviewed the Draft Environment Statement prepared by your office for the Operation and Maintenance of Pools 24, 25, and 26, Mississippi and Illinois Rivers and have no comments to offer on the proposed undertaking.

Sincerely yours,

A. L. Frank

A. L. Frank
Acting Regional Administrator

DEPARTMENT OF TRANSPORTATION
REGIONAL REPRESENTATIVE OF THE SECRETARY

ROOM 634, FEDERAL BUILDING
601 EAST 12th STREET
KANSAS CITY, MISSOURI

REGION VII

August 29, 1975

Mr. Jack R. Niemi
Chief, Engineering Division
St. Louis District, Corps of Engineers
210 North 12th Street
St. Louis, Missouri 63101

Dear Mr. Niemi:

Our review of the Corps of Engineers' Draft Environmental Statement covering the Operation and Maintenance of Pools 24, 25, and 26, Mississippi and Illinois Rivers, indicates that the Statement adequately considers the effects the project may have on areas within the jurisdiction of the Department of Transportation.

Thank you for the opportunity to comment on this draft.

Sincerely,

R R Waesche

R. R. Waesche, RADM USCG (Ret.)
Secretarial Representative
Region VII

cc:
Mr. John B. Kemp FHWA
RADM G. H. P. Bursley, USCG
Mr. William E. Loftus, FRA

DEPARTMENT OF TRANSPORTATION
UNITED STATES COAST GUARD

MAILING ADDRESS: U.S. COAST GUARD (G-WS/73)
WASHINGTON, D.C. 20590
PHONE: (202) 426-2262

9 SEP 1975

Mr. Jack R. Niemi
Chief, Engineering Division
St.Louis District, Corps of Engineers
210 North 12th Street
St.Louis, Missouri 63101

Dear Mr. Niemi:

This is in response to your letter of 7 July 1975 concerning a draft environmental statement for the Operation and Maintenance of Pools 24, 25, and 26, Mississippi and Illinois Rivers.

The Department of Transportation has reviewed the material submitted. We have no comments to offer nor do we have any objection to this statement.

The opportunity to review this draft statement is appreciated.

Sincerely,

D. J. RILEY
Captain, U. S. Coast Guard
Deputy Chief, Office of Marine
Environment and Systems
By direction of the Commandant

ILLINOIS ARCHAEOLOGICAL SURVEY

109 DAVENPORT HALL UNIVERSITY OF ILLINOIS URBANA, ILLINOIS 61801

Cooperating Institutions:
University of Illinois
Southern Illinois University
Illinois State Museum

August 26, 1975

Mr. Jack R. Niemi
St. Louis District
Corps of Engineers
210 North 12th Street
St. Louis, Missouri 63101

Dear Mr. Niemi:

Thank you for your letters of July 7 and August 4 as well as enclosure of the Draft Environmental Statement for Operation and Maintenance, Pools, 24, 25, and 26, Mississippi and Illinois Rivers.

The archaeological statement on page 189 as applies to the Lower Illinois River Valley is acceptable at this time since an archaeological survey is currently being conducted along the shoreline. The final EIS, however, should indicate the effect of future dredging and disposal sites upon the archaeological resource base in the Lower Illinois Valley and what efforts will be undertaken to preserve the existing archaeology.

The archaeological statements on page 188 as applies to the Upper Mississippi Valley are not acceptable. This paragraph begs the question about any extant archaeology by indicating that revetments would cover archaeological sites (implying that therefore they would be protected) and indicating that sites found along shorelines that erode in revetment areas would erode as a natural process and therefore the impact of the revetments on such sites is problematical. In no way does this statement make any effort to preserve the archaeological resource base. In fact, it writes off the archaeology because, following the statement, the archaeology is eroding anyway.

I therefore recommend that a detailed reconnaissance survey be undertaken of the Mississippi River Valley in Pools 24, 25, and 26 in order to determine the effect of all disposal and revetment areas on the existing archaeological resource base. In only this way will it be possible to tell the effect of the Corps project on this cultural resource.

Cordially yours,

Charles J. Bareis

Charles J. Bareis
Secretary-Treasurer

CJB:cb
cc: J. W. Porter
S. Denny
A. Dean
J. McDermott
F. Calabrese

STATE OF ILLINOIS

DEPARTMENT OF CONSERVATION

605 STATE OFFICE BUILDING
400 SOUTH SPRING ST.
SPRINGFIELD 62706

ANTHONY T. DEAN
DIRECTOR

HAROLD L. ELLSWORTH
ASSISTANT DIRECTOR

CHICAGO OFFICE—ROOM 100, 160 N. LA SALLE ST., 60601

August 4, 1975

Mr. Jack R. Niemi
Chief, Engineering Division
Dept. of the Army
St. Louis District, Corps
of Engineers
210 North 12th Street
St. Louis, Missouri 63101

Dear Mr. Niemi:

My staff has completed review of the Draft Environmental Statement, Operation and Maintenance, Pools 24, 25, and 26, Mississippi and Illinois Rivers

We feel that the section dealing with the affect of your project on the Historic, Architectural and Archeological Sites adequately takes into account the views of professionals in those fields.

This letter will serve as an acceptance by our office of the general draft statement as it pertains to the cultural environment. It does not constitute State Historic Preservation Officer "sign-off" for site specific projects covered by this statement.

Thank you for allowing us to comment.

Sincerely,

Anthony T. Dean

Anthony T. Dean
State Historic Preservation
Officer
State of Illinois

ATD/lg

Recycled Paper

ILLINOIS STATE GEOLOGICAL SURVEY

NATURAL RESOURCES BUILDING, URBANA, ILLINOIS 61801 TELEPHONE 217 344-1481

Jack A. Simon, Chief

August 29, 1975

Mr. Jack R. Niemi
Chief, Engineering Division
St. Louis District, Corps of Engineers
210 North 12th Street
St. Louis, MO 63101

Dear Mr. Niemi:

This letter is written in response to your request for comments on the Draft Environmental Statement for the Operation and Maintenance of Pools 24, 25, and 26, Mississippi and Illinois Rivers. The impact discussed is to relate to the maintenance of a 9-foot channel and involves pool regulation, dredging, and placement of dredge material, and maintenance of dikes and revetments.

Portions of the draft dealing with geology were reviewed by members of our Survey, and comments are as follows:

The discussion of Paleozoic and Pleistocene formations is factual and more than adequate. Errors in spelling on Figure 2-4 (correct spelling is CENOZOIC, MESOZOIC, PALEOZOIC, ORDOVICIAN, and ABBOTT), should be corrected for final draft.

Table 2-2 showing mineral production in 1972 for counties bordering the study area may be somewhat misleading, because these figures do not indicate the potential resource of a county. For example, in the past, clay has been produced from Morgan, Pike, Green, Madison, and Calhoun Counties, and although these counties did not have production in 1972, they have the potential for future production.

The geologic and soils portions of this draft could be combined to show relationships between these disciplines. For example, the geologic nomenclature could have been shown for the parent materials shown in Figure 2-16 in addition to material types.

The character of materials dredged as shown in Tables 10 and 11 in Appendix B, Water Quality, should be defined as to particle size and material type. It was not clear where these tables were discussed in the text. Plans for potential uses of dredged materials have a stronger case when the properties of the material are better defined.

Examination of Figure 2-5 from our Circular 478, "Geology Along the Illinois Waterway - A Basis for Environmental Planning," used the term "Sparland Formation" for "Lacon Formation." This is an error in publication for which we apologize.

Mr. Jack R. Niemi - 2 August 29, 1975

Some of our reviewers felt that the draft included more geologic detail than was needed for the impact statement. We do appreciate the more concise presentation utilizing the technique of referring the reader to appendices or other reference material.

I hope these comments are helpful. If you have any questions, we would be pleased to discuss the statement with you.

Yours very truly

Paul B. [illegible]

Paul B. [illegible]
Coordinator
Environmental [illegible]

Christopher S. Bond
Governor

State of [illegible]
OFFICE OF ADMI[illegible]
Jefferson City [illegible]

J. Neil Nielsen
Commissioner

Mark L. Edelman
Deputy Commissioner

September [illegible]

Mr. Jack R. Niemi, Chief
Engineering Division
St. Louis District
Corps of Engineers
210 North 12th Street
St. Louis, Missouri 63101

Dear Mr. Niemi:

Subject: Draft Environmental Stat[illegible] for [illegible]on and Maintenance of Pools 24, [illegible] and 26, [illegible]pi and Illinois Rivers.

The Division of State Planning, as [illegible] Clearinghouse, has coordinated a review of the [illegible] draft environmental impact statement with [illegible] state agencies pursuant to Section [illegible](c) [illegible]onal Environmental Policy Act.

Enclosed please find the comments [illegible] state agencies involved in the review [illegible] recommendations to offer at this time.

We appreciate the opportunity [illegible] and [illegible] receiving the final environmental [illegible] prepared.

Sinc[illegible]

[illegible]

OURI DEPARTMENT OF CONSERVATION

[illegible]

September 2, 197[illegible]

Mr. Terry Rehma
Clearinghouse Coordinator
Division of State Planning and Analysis
Office of Administration
State Capitol Building - Room B-22
Jefferson City, Missouri 65101

Dear Mr. Rehma:

Attached are our comments on the St. Louis Dist[illegible] [illegible]raft Environ mental Impact Statement for Operation and Maint[illegible] [illegible] of Naviga[illegible] Pools 24, 25 and 26.

The opportunity to offer comments is appreciate[illegible]

Sincerely,

Larry R. [illegible]

LARRY R. GA[illegible]
DEPUTY DIREC[illegible]

cc: U. S. Fish and Wildlife Service
Rock Island, Illinois

COMMENTS

of the

MISSOURI DEPARTMENT OF CONSERVATION

on the

DRAFT ENVIRONMENTAL IMPACT STATEMENT

for

MISSISSIPPI RIVER POOLS 24, 25 and 26

1. Page 1 - Section 1.2 - In its natural state the Mississippi River provided habitat for an abundance of fish and wildlife.

2. Page 3 - Last three paragraphs of Section 1.2.1. Side channels can fill with sediment due to natural processes, however, the last paragraph describes how this process is aggravated. The last paragraph should precede the paragraph beginning with "To alleviate".

3. Section 1.2.2 - What was the impact on fish and wildlife habitat of further contractions of the river to provide a 6 foot channel?

4. Page 17 - Section 1.3.4 - Pages 7, 9 and 10 state that the average river width is: (1) Pool 24 - 1,900 to 2,300 feet; (2) Pool 25 - 1,800 to 1,300 feet in one reach and 2,500 feet downstream; and (3) Pool 26 - 2,700 to 1,900 feet. How, with limited pipeline can the Dredge Kennedy provide even a small degree of flexibility in selecting dredge spoil disposal sites?

. Page 42 - Section 2.1.2 - The Colorado State University report is not cited. Is it public information and available for our further review and study?

Page 44 and 49 - What is the degree of accuracy of data in Table 2-3 and Table 2-4?

. Pages 42 through 54 - Information on the river in Sections 2.1.2 is of interest, however, use of uncontrolled data as a basis for estimating [illegible] changes is questionable. Is the river stage in each survey comparable? Were surveys preceded by floods or drought?

[illegible]. Page 66 - There appears to be an omission of "present day data" since the EIS jumps from 1929 to the future. Why, for instance, aren't 192[illegible] data and 1968 or 1974 data compared?

[illegible]. Page 83 - Information from 1891 indicated the river area was 65.556 sq a miles; almost identical to the pools in 1972.

[illegible]0. Page 91-92 - Fishery information taken from Nord, 19[illegible], represents [illegible] entire Upper Mississippi River, and may not be indicative of Pools [illegible] and 26.

11. Page 117 - Harvest information for Missouri whitetail deer is misleading. S[illegible] successful hunters spent less time in the field and represent only 16 [illegible] the hunters in the field, the total dollar value is grossly underestim[illegible]

12. Page 151 - The point made in the last sentence concerning the impact of drought on the river system should be considered regarding Comment No. 7, above.

13. Page 153 - Paragraph 5 - There has been a [illegible] percent loss of river area in the upper portion of Pool 25. Based on a comparison of [illegible] 1973 data, there has been essentially no change in river [illegible].

14. Page 158 - Table 4-6. What is the validity [illegible] data? Was data taken from the same locations in each [illegible]? What is [illegible] total storage of the pools in 1972 vs. 1939?

15. Page 161 - Section 4.1.1.4 - If some portion of the pools [illegible] not filling with sediment, how could "upstream dams have decreased [illegible] amount of sediment coming into the study reach"?

16. Page 164 - Paragraph 3 - We do not agree that flooding [illegible] "not [illegible] appreciably during the period of record". Tables [illegible] and 4-11 [illegible] of [illegible] since only one pre-dam year is in the top ten discha[illegible] stage and 4th in discharge). More recent years have higher stages [illegible] discharge.

17. Page 169 - Paragraph 6 - With limited equipment, [illegible] to understand how spoil can be disposed in the area [illegible].

18. a. Page 170 - Table 4-13 - Data on [illegible] ingless to most individuals. In the past 12 years [illegible] spoil would

make a pile 3 feet deep and 270 feet wide for the entire 105 miles in the project area.

b. Data do not indicate the fact that dredging occurs in divided channel reaches, the most important areas for fish, wildlife and associated recreation.

19. Page 172 - Paragraph 5 - No plans for new dikes are being made. What plans have been made for improving existing dikes?

20. Page 179 - Last Paragraph - Dikes provide habitat for some benthic organisms. Freshwater mussels for instance, do not benefit from dikes.

21. Page 180 - First paragraph - The value of root wads and fallen trees associated with the natural bankline is not considered.

22. Page 184 - Last Paragraph - Recognition of the fact that the Mississippi River is dynamic is noteworthy. The Middle Mississippi River Draft Environmental Impact Statement seemingly failed to indicate that the river was a dynamic

23. Page 184 - a. Paragraph 2 of Section 4.2.3 - This paragraph is not clear. How does conversion to intensive agriculture benefit habitat diversity?

b. Paragraph 3 - Dredged material could be detrimental to the river otter.

24. a. Page 200 - Paragraphs 2 and 3 - Dredge spoil is good for beaches, however, the problems of erosion and redeposition, plus the fact that vegetation will convert the sand beach to a wooded island should be discussed.

b. We disagree that dredge spoil "will have minor effects on aquatic communities". The elimination of aquatic life, freshwater mussels, or other benthic organisms is of concern.

A discussion of the following points should be included: (1) the lack of the necessary equipment to make the best use of dredge spoil; (2) dredge problems occur most often in divided flow reaches, the areas of most significance to fish, wildlife and associated recreation. Without equipment to properly place dredge spoil, the discussion of beneficial uses is incongruous.

c. The last paragraph of Section 6.2.3 is somewhat incompatible with page 114.

25. Page 201 - First complete paragraph - If sand and gravel companies were [illegible] an opportunity to bid on dredged material, it might alleviate their loss of business and provide some revenue for the Federal Treasury.

26. Page 203 - a. Last Sentence of Section 6.2.7. What is the basis for the statement that the biological life may not be significantly affected by removing [illegible] material?

b. Section 6.3.1. If laws are limiting the flexibility of operation, can't [illegible] be changed?

c. Section 6.3.2. If increasing the pool level will reduce sediment transport, how can the data showing no change in the bottom elevation of the pools [illegible] 1929 and 1970 be valid?

27. Page 204 - Section 6.3.3. What is the purpose of the pool fluctuations discussed in this section?

28. Page 206 - Paragraph 4 - The primary impact on fish and wildlife is the placement of spoil and conversion of water areas to relatively sterile sand bars. When the material moves, secondary impacts and tertiary impacts occur.

29. Page 207 - a. What specific law is cited in the first complete paragraph?

b. The placement of dredge spoil is a short term benefit to recreation. Sandbars grow up in willows, erode away, and the river is narrowed and made less desirable for all uses in the long term.

30. Page 208 - Paragraph 3 - The project does encourage development of comme[illegible] and industrial facilities, which often leads to a further loss of water quality, habitat and lands dedicated to fish, wildlife and recreational uses.

CHRISTOPHER S. BOND
GOVERNOR

JAMES L. WILSON
DIRECTOR

missouri department of natural resources

P.O. Box 176 Jefferson City, Missouri 65101 314-751-3332

August 5, 1975

Mr. Terry L. Rehma
Office of Administration
Room B-9, State Capitol Building
Jefferson City, Missouri 65101

Re: A-95 Review Number 75070045 - U.S. Army Engineer District, St. Louis, Missouri - Draft EIS - Operation and Maintenance Pools 24, 25 & 26, Mississippi and Missouri Rivers

Dear Terry:

The Department of Natural Resources has reviewed the above noted project and has the following comments to offer.

1) Dredging activities can destroy underwater archaeological sites such as sunken boats, steamboat wrecks, or boats involved in Military operations during the Civil War, etc. Hence, if such a wreck is found during dredging projects, the Corps or its subcontractors should cease operations and notify this office.

2) If the construction of bankline revetments or dikes involves disruption of portions of the shoreline, these areas must be professionally evaluated prior to ground disruption activities.

3) If the construction or repair of bank revetments covers an area where old soil has been previously deposited, an evaluation of the specific area would not be necessary, provided the disturbance does not extend to previously undisturbed or modified areas.

4) There are no sites listed on the National Register of Historic Places which will be affected by this project. There are several sites listed on the Register within 1 - 4 miles of the Mississippi River, but none is in the direct impact area.

Sincerely yours,

DEPARTMENT OF NATURAL RESOURCES

James L. Wilson
Director

JLW:crc

cc: Mr. Jack R. Niemi
Chief, Engineering Division
Department of the Army
Corps of Engineers
210 N. 12th Street
St. Louis, Missouri 63101

Richard G. Leverty
Office of the Chief of Engineers
DAEN-CWP-V
Washington, D.C. 20240

Roy W. Reaves III
Executive Order Consultant
National Park Service
Denver Service Center
655 Parfet Street
P. O. Box 25287
Denver, Colorado 80225

John D. McDermott
Director, Office of Review & Compliance
Advisory Council on Historic Preservation
Room 430
1522 K. Street, N.W.
Washington, D.C. 20005

Jordan Tannenbaum
Advisory Council on Historic Preservation
Room 420
1522 K. Street N.W.
Washington, D.C. 20005

Southern Illinois
University

CARBONDALE, ILLINOIS 62901

Cooperative Wildlife Research Laboratory

July 10, 1975

Jack R. Niemi
Chief, Engineering Division
St. Louis District, Corps of Engineers
210 North 12th Street
St. Louis, Missouri 63101

Dear Mr. Niemi:

I would be happy to comment on the Draft Environmental Statement for Pools 24, 25, and 26.

Summary Sheet: 3.a. Paragraph 4. This statement on dikes and revetments totally ignores the adverse effects on terrestrial organisms as delineated in the text.

You neglected to request comments from those individuals best qualified to discuss the environment--the professional biologists who have researched the plants and animals. Environmental groups like Audubon and Sierra Club are primarily unprofessional people interested in the environment.

Page 185, Paragraph 2. This paragraph does not hold the connotation I meant it to have. The original paragraph read "Indirectly, the navigation [illegible] dams have been detrimental to wildlife by increasing barge traffic cap[illegible] on the rivers. Locking accidents by commercial carriers of toxic and flammable cargoes have produced pollution. The pumping of waste materials from vessels into the rivers is still a common practice and is difficult [illegible] detect. In addition, wave action from barges causes bank erosion and substantial water elevation changes in tributaries."
I hope you are not naive enough to believe the barges when they say they don't do it. There is a definite environmental problem there, and your paragraph just glosses over it. As you well know, it is often these minor points that get you into trouble.

Basically, I am disappointed with Environmental Impact Statements. They cover the material but don't say a damn thing. Thank you for the opportunity to express my opinions.

Sincerely,

Virginia A. Terpening

Mrs. Virginia A. Terpening
Wildlife Biologist

University of Missouri – Columbia

Room 22 Switzler Hall
Columbia, Missouri 65201

COLLEGE OF ARTS AND SCIENCE
Archaeological Survey

Telephone
314-882-83

July 16, 1975

Mr. Jack R. Niemi
Chief, Engineering Division
Department of the Army
St. Louis District, Corps of Engineers
210 N. 12th St.
St. Louis, Mo. 63101

Dear Mr. Niemi:

This will acknowledge my review of the Draft Environmental Statement entitled "Operation and Maintenance, Pools 24, 25, and 26, Mississippi and Illinois Rivers" prepared and distributed with your covering letter 8 July 1975, and your correspondence noted LMSED-BA.

This statement regarding the impact of operation and management of archaeological resources seems to be in order and has considered the archaeological resources to be found in the area, especially in the Missouri re tion of this reach of the Mississippi River. I agree that the statements on impact of dredging materials on archaeological sites is important and am pleased to know that such materials are not deposited on the bank along the Mississippi and the Missouri.

Your reference to work by Denny, 1975, I fail to find mentioned in the bibliography and would be interested to have a copy of such material deposited with the Archaeological Survey to give us information on survey work conducted in Missouri for future reference. I also suggest that that reference be included in the bibliography.

If you have any questions please contact me.

Sincerely yours,

David R. Evans
Manager

DRE:clm

CITY OF ST. LOUIS
DEPARTMENT OF PUBLIC UTILITIES
WATER DIVISION

CONWAY B. BRISCOE-COMMISSIONER
1640 So. KINGSHIGHWAY
ST. LOUIS, MISSOURI - 63110

JOHN H. POELKER
Mayor

WALTER T. MALLOY
[Di]rector of Public Utilities

DIVISION ENGINEERS

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STANLEY T FLETCHER
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771-4841

HAROLD B WELGE
OPERATING
867-3460

July 15, 1975

Mr. Jack R. Niemi
Chief, Engineering Division
St. Louis District, Corps of Engineers
210 North 12th. St.
St. Louis, Missouri 63101

Regarding LMSED-BA
Draft Environmental Statement for the Operation and Maintenance of Pools 24, 25 and 26 Mississippi and Illinois Rivers.

The St. Louis Water Division has no objections to offer. This will not effect the quality of the river water at our point of intake.

Sincerely yours,

Walter C. Zollmann

Walter C. Zollmann
Chief Chemical Engineer
St. Louis Water Division
10500 Riverview Drive
St. Louis, Missouri 63137

**Advisory Council
On Historic Preservation**
1522 K Street N.W.
Washington, D.C. 20005

September 3, 1975

Mr. Jack R. Niemi
Chief, Engineering Division
St. Louis District
Corps of Engineers
U.S. Department of the Army
210 North 12th Street
St. Louis, Missouri 63101

Dear Mr. Niemi:

This is in response to your request of July 7, 1975, for comments on the draft environmental statement for the proposed Operation and Maintenance of Pools 24, 25, and 26, Mississippi and Illinois Rivers. Pursuant to its responsibilities under Section 102(2)(C) of the National Environmental Policy Act of 1969; the National Historic Preservation Act of 1966; Executive Order 11593 of May 13, 1971; and the Council's "Procedures for the Protection of Historic and Cultural Properties" (36 C.F.R. Part 800), the Advisory Council on Historic Preservation has determined that while you have discussed the historical and archeological aspects related to the proposed undertaking, the Council needs additional information on archeological resources to adequately evaluate the effects on those cultural values. Please furnish additional data indicating:

> Compliance with Section 800.4(a) of the Council's Procedures.
>
> Under Section 800.4(a), the Corps of Engineers is responsible for identifying archeological sites located within the area of the undertaking's potential environmental impact that are eligible for inclusion in the National Register of Historic Places. In this regard, we request that if the construction of bankline revetments or dikes involves disruption of portions of the shoreline, these areas be professionally surveyed by the Corps.

In addition, we support the August 5, 1975, position of the Missouri State Historic Preservation Officer concerning protection of unknown underwater archeological resources that may be affected by the proposed undertaking.

The Council is an independent unit of the Executive Branch of the Federal Government charged by the Act of October 15, 1966 to advise the President and Congress in the field of Historic Preservation.

Until archeological resources in the project area have been identified and the need for further compliance with the Council's procedures has been ascertained, the Council cannot comment favorably with respect to your environmental statement.

For further information and assistance in this matter please contact Jordan Tannenbaum of my staff at 202-254-3380.

Sincerely yours,

John D. McDermott
Director, Office of Review and Compliance

Missouri Chapter
of the
American Fisheries Society

CHARTERED MARCH 10, 1964

September 2, 1975

Colonel
U.S. Army Engineer District-St. Louis
Corps of Engineers
210 North 12th Boulevard
St. Louis, Missouri 63101

Dear Colonel:

The Environmental Impact Committee of the Missouri Chapter of the American Fisheries Society is making comment on your proposed plan of operation and maintenance of Pools 24, 25, and 26 of the Upper Mississippi River. These comments are being final typed and will be transmitted to you later this week.

We appreciate the opportunity to make comments.

Sincerely,

Joe G. Dillard, President
Missouri Chapter of the
American Fisheries Society

Comments of the Missouri Chapter of the American Fisheries Society on the Draft Environmental Statement for the Operation and Maintenance of Pools 24, 25, and 26, Mississippi and Illinois Rivers.

This statement is relatively well written, although marred by wordiness and redundancies. It presents an interesting account of the historical development of control works to facilitate navigation on this portion of the Mississippi River. Much space is taken up with economic and sociological detail, apparently aimed at justifying the need for commercial navigation on the river. Since the 9-foot channel was authorized by Congress and since this statement should be concerned only with the effects of the project on the environment, such justification seems superfluous and out of place.

Justification is needed in other areas, however. Why is it necessary to spend millions of dollars on operation and maintenance on these three navigation pools at this time? The structures to be repaired were installed to control the free flowing river before the locks and dams were built in the mid-30's. It was not deemed necessary to repair the structures in the 30-odd years between impoundment and 1969. Since 1969 a movement has been underway to rehabilitate the old dikes and revetments and an average of $4,577,000 annually has been expended in the past five years. The need for this maintenance work has not been adequately justified.

Of the alternatives presented, that of ceasing all operations and maintenance appeals most to us. The effects on the environment would generally be to the good. It is unlikely that recreational use would decrease, rather it probably would increase as the habitat returned to a more natural state and the hazards associated with commercial traffic

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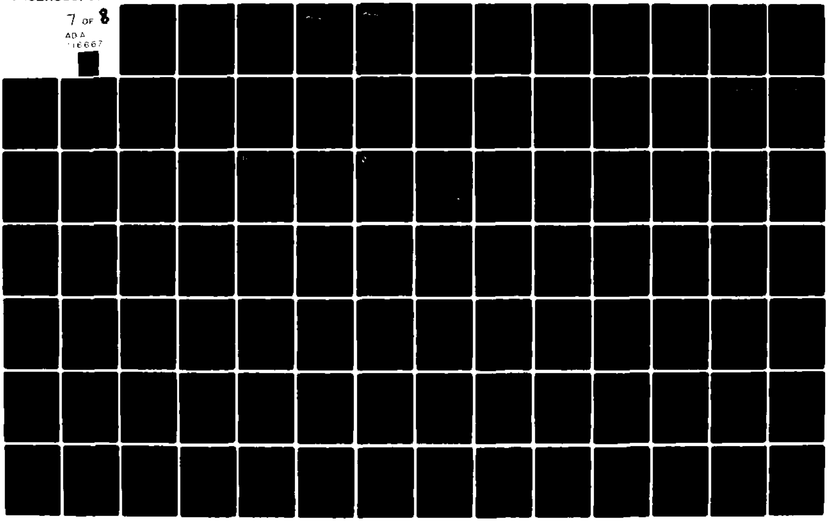


decreased. We recognize, however, that this is not a real alternative. Navigation is a long established use of the Mississippi River, various phases of the navigation project has been authorized by Congress, so the barges will continue to run and the dredges to dig.

Dredging and the deposition of dredge spoil, without doubt, have the most serious environmental impacts of any of the activities covered by this statement. Some dredging apparently is necessary if a navigable channel is to be maintained. This is one of the most expensive aspects of channel maintenance and, since large quantities of sandy material have to be moved considerable distances, the deposition of dredge spoil is also expensive. Anything which tends to increase the distance the spoil must be moved, increases the cost. These simple facts, however, are never clearly stated in the statement.

Several alternative methods of dredge spoil placement are presented in Section 6.2 of the statement. One of these is to equip the present dredges with additional facilities so that spoil can be placed selectively. It is estimated that it would cost $977,000 for additional equipment and $432,000 annually in additional operating costs to increase the length of the discharge pipe of the dredge "Kennedy" from its present 850 ft. to 1,900 ft. Other alternatives cited possibly are more costly since most would require movement of spoil for greater distances. No cost estimates are given, however, so comparisons can not be made. Many of the alternatives have desirable features which might offset higher costs but without cost estimates it is difficult to make a judgement. Thalweg placement (6.2.2) seems to have much to recommend it but cost estimates are missing and apparently more research is needed to acertain downstream effects.

It seems to be implied in Section 6.3 that fluctuations in pool

water levels could make unnecessary much of the dredging now being done. This alternative is not adequately explored, possibly because of limitations imposed by the "Anti-Drawdown Law". Of course, pool level fluctuations have far reaching effects, not only in the river but in the neighboring flood plain and all of these need to be taken into account. It is not possible, however, to evaluate the alternative from the meager information provided.

The alternative section (6) of this statement is unsatisfactory. At least one alternative presented is not really an alternative. Use of the Mississippi River for commercial transportation and maintenance of a navigation channel by the Corps of Engineers are long established practices and not likely to be changed. Therefore, abandonment of all maintenance and operational work is not a real alternative. As has been pointed out, it is impossible to evaluate alternatives unless estimates of their cost and full research into their effects are presented. This has not been done. We recommend that this section be rewritten to present real alternatives in such a manner that realistic judgements among them can be made.

The statement deals with spills of deleterious substances (petroleum products, toxic chemicals, etc.) in a very superficial way. Spills are a very real hazard of modern freight hauling and they can be especially damaging when they occur on a waterway. For these reasons the subject should be thouroughly treated in an environmental impact statement. The type, frequency, magnitude, and environmental damage of past spills should be enumerated. Accidental spills probably can not be prevented on a stream used for commercial navigation but resulting damages can be greatly reduced if proper measures are taken to prevent occurrence and effective methods are used to contain and clean up those that do occur. The state-

ment should present a review of precautionary measures in effect to prevent spills when loading and unloading deleterious substances at each port and of plans to contain and clean up spills in each reach of the river, including responsible agencies, and equipment and personnel available for the purpose.

It is well known that a large number of the spills which occur on a navigable stream such as the Mississippi River are deliberate dumpings of unwanted cargo. This may be done to lighten a grounded barge, to rid barges of residues of the last cargo in preparation for the new, or any number of reasons. The statement passes over these lightly with the comment that they are illegal. This is true, of course, but they occur because the stream is used for navigation and because many of the barge operators choose to flout regulations. The fact that the spills are the result of illegal activity does not lessen the damage done to the environment. This statement would be much more palatable to environmentalists if it contained some indication that the commercial barge lines were making a serious attempt to police themselves to prevent this type of illegal activity.

Migratory Waterfowl Hunters, Inc.

P.O. Box C
GODFREY, ILLINOIS 62035

SPONSOR--DUCKS UNLIMITED

August 29, 1975

Jack R. Nieme
Chief, Engineering Division
St. Louis District, Corps of Engineers
210 North 12th St.
St. Louis, Mo. 63101

Sir;

We are pleased to enclose our comments on the "Draft Environmental Statement on the Operation and Maintenance Pools 24, 25 and 26 Mississippi and Illinois Rivers".

The 9' Channel Project has been a great public service performed by the Corps of Engineers, but there are environmental costs, which until recently, have not been given serious consideration except by the more foresighted individuals. The MWH organization is young, but we have quickly recognized the need to work constructively toward the solution of these and other problems.

Our relationship with the St. Louis District has been fruitful, mainly because individuals, within the Corps, and Corps policy, in some instances, has sought constructive public participation. The problems we face in the 9' Channel Project are not insurmountable, but will only be conquered if that public input and cooperation is actively sought.

Sincerely,

William P. O'Neal

William P. O'Neal
Special Projects

WPO/do

Enc.

Migratory Waterfowl Hunters, Inc.

P.O. Box C
GODFREY, ILLINOIS 62035

SPONSOR--DUCKS UNLIMITED

MWH COMMENTS ON DRAFT E.I.S. "OPERATION & MAINTENANCE POOL 24, 25 AND 26 MISSISSIPPI & ILLINOIS RIVERS

<u>Summery Sheet</u>: Should be rewritten to include the direct effect which is allowed by the 9' Channel Project, namely barge traffic and it's effect on the Mississippi and Illinois Rivers.

1.2 This part should contain brief material which accurately conveys the social, cultural and environmental conditions of the region and their changes as the river was developed for navigation purposes.

1.5.1 We are of the opinion that the extent to which tows have presently experienced delays at Lock & Dam 26 is more a function of the nature of the commodities being shipped rather than deficiencies in the structure.
Replacement of Lock & Dam 26 will have an effect far greater than reduced maintenance cost and reduced locking delays. It will effect the other two dams and the Illinois River portion of Pool 26.

2.2.2.6a The values stated for consumptive and nonconsumptive economic importance of wildlife is misleading. The economic values asserted for consumptive uses have been developed from data that is mainly objective in nature, while the data for nonconsumptive uses was highly subjective. It is a comparison of apples and oranges and should be clearly labeled as such in the text where it appears.

4.1.1.3 Table 4-10 appears to show an increasing flood stage and frequency since the 9' Channel Project was implemented. No explanation is given in the text.

4.1.4.4 Barges have been trapped or held in Pool 26 with extremely hazardous material during winter months by ice and thus subjected the residents to risk that they would not otherwise be subjected to.

4.2.2.2 There is no indication that impacts upon migrating waterfowl and other birds of the Mississippi Flyway, in which the dams are centered. was studied. Knowledge relating to timing of dredging operations and its short term effect on waterfowl habitat for the Spring and Fall migrations, as well as long term effects, should be included.

4.2.2.2c An appendix should be added which gives justification to the conclusions that Federal and State regulations "greatly reduce the amount of waste entering the waterways" from barges.

4.2.3 The term "indiscriminate hunting" should be removed. Since the authorization of the 9' Channel Project, no form of hunting has materially contributed to the reduction of threatened, rare or endangered species. In addition, since the authorization of the 9' Channel Project, the adjacent states have regulated hunting so that such hunting (if it were to have existed) must have been illegal rather than indiscriminate.
A differentiation should be made in the text between those species which are rare in nature and those that are rare in the project area but occur elsewhere in abundance. Barge travel has been observed to directly affect the canvasback duck that regularly winters over in Pool 26.

4.3 The project has decreased the aesthetic appeal in some of the project areas by facilitating the beaching and tieing up of barges and the operation of barge terminals.

4.3.2b The regional economy is also affected by the recreational uses of the 9' Channel and the expenditures for personnel and equipment by the Corps of Engineers.

4.4c One impact is clear. As a result of the 9' Channel Project large land holdings have been set aside to the benefit of wildlife and public recreation. It is not likely that these holdings would have occured otherwise. Funds of other Federal and State agencies that might have been required for acquisition purposes to meet the recreational needs of the area have been freed for use on other projects or areas.

4.5 This section should be rewritten to at least contain by reference the data presented in other portions of the Draft E.S. in addition to fishing. The adverse impacts on recreation on Upper Mississippi and Lower Illinois Rivers will result in a shift of demands and costs to State agencies and the private sector which they may not be able, or prepared, to meet.

6.2 We support the continued operation of these Locks and Dams. Greater emphasis must be given to the solutions or reparations made for the adverse impacts. We are aware of legal, traditional and institutional constraints which have in the past affected the St. Louis District's ability to recognize and define problems in other than navigational interest terms.
It is highly unlikely that any single alternative listed in this section would, by itself, be the solution to the adverse impacts associated with the project. Section 6.2.6 is the most desirable. As a practical matter, a combination of Selective Placement options guided by the principle of least environmental damage, improvement of recreational opportunity and greatly reduced emphasis on the cost of moving dredged materials would be an acceptable option. Ongoing studies should be made to identify areas where siltation, natural and that resulting from dredging activities, have occured which have dysfunctional effects on recreational uses such as waterfowl habitat and hunting and corrective measures taken. This should be a regular function as part of the operation and maintenance.

6.3.1 A study should be made of the effects of the "Anti-Drawdown Law" and the desirability of changes in that law so that the benefits of water level management may be gained for wildlife.

9.2 The Coordination efforts leading to the preparation of this environmental impact statement should be a regular part of the operation plan of this project with the idea of a continued identification of problems and search for solutions.

William P. O'Neal

William P. O'Neal
Special Projects
Migratory Waterfowl Hunters, Inc.

Sierra Club

August 28, 1975

Thorwald R. Peterson
Colonel, CE
District Engineer
210 No. 12th Street
St. Louis, Missouri 63101

Dear Colonel Peterson,

Members of the Piasa Palisades Group, Sierra Club located in Southwestern Illinois have been designated as the unit of the Sierra Club to offer comment to the Draft Environmental Impact Statement - Operation and Maintenance (Navigation) Pools 24, 25, and 26 - Mississippi and Illinois Rivers.

Enclosed are our comments.

Sincerely

Robert H. Freeman

Robert H. Freeman
Sierra Club, Piasa Palisades
Group
43 Kaskaskia Trail
Godfrey, Illinois 62035

PIASA PALISADES GROUP

Southwestern

OPERATION AND MAINTENANCE POOLS 24, 25 and 26

MISSISSIPPI AND ILLINOIS RIVERS

INTRODUCTION

A. Citizen Interest. For several years now there has been a growing citizen interest in the poor treatment that has been afforded our nations' big rivers. The Upper Mississippi River is truly the most significant natural resource in the Midwest, yet because of inadequate long range planning and the pressures of special interest groups, the quality of the Upper Mississippi River and the tributary Illinois River has grown over the years progressively worse.

For years the prime use of the rivers have been for navigational purposes and countless millions of governmental dollars have been pumped into "development" works designed to promote and facilitate navigation. No one who has read this Draft EIS would disagree that although there have been profits made by some as a result of the many navigational works, there has also been severe environmental damage as a consequence.

It is with relief that we arrive at this point in time where some consideration is also to be given to our natural environment. River corridors provide the only natural habitat remaining in our heavily populated, industrialized and intensively farmed midwest area and the Sierra Club is determined to see that other uses of the river are given equal consideration.

B. The NEPA Act of 1969.

As has been pointed out separately in the Sierra Club comments on O&M of the

Middle Mississippi River, Congress created the NEPA Act to "reverse what seems to be a clear and intensifying trend toward environmental degradation," and they were particularly concerned about the impact on the environment by federal agencies which were by prior acts of Congress, "development-oriented"; that is, agencies which had developed over the years institutional policies which promoted economic development and new generations of technology without regard to their future effects on the environment.

The Sierra Club regrets that it took the St. Louis District more than five years to initiate environmental studies as required by law on the issue of operation and maintenance of the navigational channel. Instead of devoting manpower [illegible] environmental studies on the Upper and Middle Mississippi Rivers, major efforts were instead directed toward engineering studies in anticipation [illegible] construction of a new dam to replace L&D 26, reconstructing and improving [illegible] investments in the Upper Mississippi River reach, coordination with the Kansas City District on planning for the ill-advised Unit L-15 Levee Proposal, and so forth - the very reasons that NEPA was created by Congress. Other Corps districts in the midwest have had EIS studies under way for several years on O&M of the navigational channel.

DEFICIENCIES WITHIN THE DRAFT STATEMENT

A. General Impressions. Given that the SLD has been so reluctant to begin environmental studies, favoring instead the continuation of engineering projects, it is not surprising to find that the general tone of the EIS is merely an extension of previous commitments that are navigation-oriented. Many of the statements are openly defensive of the historical alliance between the Corps and the navigation interests. Some of the supportive data is presented in a scattered and inconsistant manner.

B. Future Impacts Ignored

The overriding deficiency in the DEIS is the fact that it considers navigation at a static level only for future years and fails to take into consideration the dynamic technology of the barge industry, the many proposals for increasing navigational development, and current projects now under way which promise to explode barge traffic four-fold without attempting to ameliorate subsequent environmental damage or to provide mitigation. Although this DEIS briefly addresses the advancing technology and several of the development proposals and projects are discussed, all subsequent examination and discussion are based upon the premise that increased navigation technologies and quadrupled traffic would have no effect on present O&M practices.

1. Twelve-Foot Channel. Foremost among concerns by citizens and other agencies of government is the much-feared Twelve-foot Channel Proposal. One 9-line paragraph within the two inch thick DEIS addresses - and promptly dismisses - the proposal. The Phase 1 Report - Twelve Foot Channel Proposal concluded that at this time the Upper Mississippi River above Grafton was economically unfeasible for further study, but that the Mississippi River above Cairo, thence the Illinois River above Grafton to Lake Michigan justified additional examination. Not only would the project cause severe initial environmental damage to implement, it would drastically affect operation and maintenance practices and would multiply all of the environment woes categorized in the DEIS. Furthermore, it must be pointed out that Congress has not de-authorized the Phase 1 Study as regards the Upper Mississippi River above Grafton. Should economic situations change and shoul other Corps projects (such as the Duplicate Locks Project on the Illinois River and L&D 26 Replacement, for instance) become reality, it would be a

simple matter for the Corps to reactivate the Twelve Foot Channel Study again to include the Upper Mississippi River above Grafton.

It should be pointed out to the SLD that nearly 100 miles of river presently considered for the 12-Foot channel falls within the area studied in this O&M DEIS; eighty miles of Illinois River and sixteen miles of Mississippi River. Furthermore, it has been clearly shown that the design of both the L&D 26 replacement and the Duplicate Locks Project on the Illinois have been engineered to 12-foot channel specifications paving the way for future system expansion plans. To summarily dismiss further discussion on this project as it would affect future O&M is unrealistic.

2. Year-Round Navigation Proposal

Totally missing in the DEIS is any mention of an active Corps proposal - the Year-Round Navigation Proposal. Perhaps the SLD has forgotten that the Phase 1 Report has been available for some time and in fact, public hearings were held in the Spring of 1974 at Rock Island and Quincy, Illinois on the issue. Virtually all of the Navigation Pool 24, 25 and 26 falls within the study area of this proposal and adoption of this plan would greatly affect O&M of the Upper Mississippi and Illinois Rivers.

O&M expenses would increase, increased dredging would become necessary, adverse environmental damage would result and navigation itself would again increase. Perhaps it is appropriate to quote from the Phase 1 Report, Mississippi River Year-Round Navigation: "...continuous navigation activities would definately increase turbidity. It is conceivable that such increased turbidity could alter the physical and chemical composition of water under the ice. This factor may represent the greatest detrimental effect."

If increased turbidity was possibly the greatest concern environmentally

the greatest concern to the SLD in terms of O&M would be how to keep the channel open. Channel bubblers to raise the warmer water to the surface, ice breaker cutter ships, hot water lines in the locks, propane-fired "cannons" to break the ice, and specially designed heating rods to keep the ice from freezing solid were some of the proposed technological solutions to the problem.

The Sierra Club regards the omission of this damaging active proposal from the DEIS as totally unwarranted.

3. Duplicate Locks Project.

In the same vein as the preceeding discussion, it should be pointed out to the SLD the omission from the DEIS of any discussion on the Duplicate Locks Project on the Illinois River. This authorized, but unfunded project would have extensive impact upon O&M of the channel within Navigation Pools 24, 25 and 26. It is puzzeling that no mention of this major authorized project was made in the DEIS. The intended purpose of the Duplicate Locks Project on the Illinois River is to encourage expanded navigational use of this waterway in annual tonnage. The means of increasing tonnage is to deepen the locks for deeper draft barges and to provide longer Locks to permit longer tows and decrease locking time.

Attendant with the increased barge traffic resulting from development of the Duplicate Locks Project are the consequenees of further degradation of the riverine environment: increased commercialization and industrialization of the flood plain, water and air pollution, dredging complications, revetment and dike construction, wave wash, increasing turbidity, increased incidences of spills and collisions - the whole gamut of guaranteed consequances of concern by citizens and governmental agencies dedicated to protection of the rivers

from environmental degradation.

4. Locks and Dam 26 (Replacement) Proposal.

This active proposal by the Corps is not an authorized project but has been briefly discussed in the O&M DEIS. The discussion allocated to this proposal in the DEIS, however, is grossly inadequate considering the major impact that this project would have on future operation and maintenance of the navigational channel. Once again, this exhibits the fact that the Corps has considered the O&M of Navigation Pools 24,25 and 26 from a historical , or "looking backwards" viewpoint rather than a forward outlook which is pl [illegible] ued with a host of governmental subsidized projects intended to benefit one special interest group.

Numerous Corps documents and trade publications of the navigation industry have made it clear that the purpose of replacing L&D 26 is to provide increased depth for the channel so that a 12-foot channel would be effected. Design Memorandums for L&D 26 indicate a sill depth being designed into the proposed structure of 18 feet.

> "A 12-foot channel project must have a minimum depth of 15 feet over lock sills to provide adequate vessel clearance for efficiency and safety of operations." [1]

The effects of deeper draft barges, increased barge technology (including recent 10,000-plus horsepower tugs), quadrupled traffic, year-round navigation, and general governmental subsidized growth patterns which detrimentally affect existing land uses has been hurriedly glossed over in this evaluation of O&M environmental impact.

5. Lake Michigan Water Diversion. Yet another impending proposal which would have adverse environmental consequences within Navigation Pool 26

is the current study to divert additional waters from Lake Michigan through the Chicago Sanitary and Ship Canal and subsequently into the Des Plains and Illinois Rivers. The proposal would increase the present 3,200 cubic feet per second of water that is artificially discharged into the Chicago River to be increased to 10,000 cubic feet per second. No mention of this possible project was examined in the DEIS contrary to NEPA regulations which require consideration of related project works. Permanently increasing the rate and volume of flow may have major impact on environmental aspects.

6. Summary of Deficiencies Relating to Future Project Works.

Five projects described above are either inadequately dealt with or are totally omitted from discussion in the DEIS contrary to NEPA regulations. Each of the above have major impacts on O&M of Navigation Pools 24, 25 and 26 if they are carried out. Each of the above proposed projects will lead to increased degradation of natural resources within the Mississippi and Illinois Rivers - both in the study area and throughout the entire system, if implemented. As in previous Corps documents and project proposals, this DEIS attempts to isolate the immediate study area or specific project as a singular development having no association with other reaches of the river or with other proposed public works and management projects.

Several legal injunctions have been recently entered against Corps projects because there had been a reluctance to evaluate entire river systems as a whole rather than evaluating each engineering works or management plan as a separate and isolated impact. It should be painfully clear to the SLD by now that engineering projects and O&M programs must be evaluated as a system whole.

C. Specific Deficiencies.

There are a number of areas within the DEIS that are incorrect and while we believe there is no deliberate attempt at misrepresentation, they

are indicators that additional studies should be continued so that the public and other governmental agencies have all of the correct facts.

1. Par. 1.3.1.1 Navigation Pool 24. Page 7.

DEIS: "Three state parks and recreation leases have been granted to the State of Illinois."

Comment: There no lands within the Navigation Pool 24 area of Illinois designated as state parks.

2. Par. 1.3.1.2 Navigation Pool 25. Page 9.

DEIS: "In addition, there are four state park and recreation leases - Titus Hollow and Red's Landing in Illinois,..."

Comment: There are no lands within the Navigation Pool 25 area in Illinois designated as state parks.

3. Par. 1.3.3.3 Navigation Pool 26. Page 13.

DEIS: "There are numerous private marinas as well as eleven state park and recreation leases; ten in Illinois and one in Missouri."

Comment: There is only one area within Navigation Pool 26 area designated as a state park - Pere Marquette State Park in Illinois.

4. Par. 1.3.4 Maintenance Dredging. Page 17.

DEIS: "To maintain a minimum 9-foot navigation channel, dredge cuts are usually made to a depth of 9-feet below the minimum pool elevation. A two foot over-depth is made to provide for any subsequent siltation;... In adition, proper clearance must be maintained between the bottom of the tow and the channel bed to prevent excessive drag forces and possible groundings."

Comment: No reference is made as to what the additional "proper clearance" requirements are. Are the proper clearance requirements one foot or more? Corps reports on the Year-Round Navigation Proposal and EIS reports on the L&D 26 replacement contend that a 9-foot build-up

of ice on the bottom of barges in the winter is commonplace. Does occurance, if factual, justify an additional dredge cut of 9 feet to provide for "proper clearance"?

5. Par. 2.1.2 River Channel Configurations. Page 45.

DEIS: "For example, a portion of the Mississippi River floodplain along the left bank opposite Hardin, Illinois...."

Comment: Hardin, Illinois lies between mile 20 and mile 25 on the Illinois River - not the Mississippi River.

6. Par. 2.4.2 General Patterns of Land Use. Page 140.

DEIS: "(Navigation) Pool 26 begins at Alton, Illinois, and stretches in a due north direction to Winfield, Missouri."

Comment: For the benefit of the engineers from the St. Louis District, the Mississippi River flows from west to east in this portion of the study area. Winfield, Missouri is almost due west of Alton, Illinois.

7. Figure 4.5 Recurring Dredge Cuts. Page 171.

Discrepancies exist in the data offered in Figure 4.5 and in Plate 9-A. Figure 4.5, for instance, indicates that there was dredging necessary at mile 208 (off Piasa Island on six occurances between 1964 and 1974. Plate 9-A, however, indicates that there has been no dredging at all at this location between 1969 and 1974.

Assuming only one dredging is necessary per year, this means that according to Fig. 4.5 data, there were one-half million cubic yards of material removed from the channel and spoiled on or near Piasa Island for five consecutive years - 1964-1968. Furthermore, the data shows that the dredge Kennedy had to return to mile 208 for a second time during one year of the 1964-1968 period and perform additional dredging - this time removing one-quarter of a million cubic yards of the material.

Data supplied by the Corps in Plate 9-A shows that during the

next six years it was not necessary to visit the site at all. This suggests to the reader of the DEIS several possibilities:

1. The data shown in Figure 4.5 is in error, or
2. The data shown in Plate 9-A is in error, or
3. Both Figure 4.5 and Plate 9-A are in error, or
4. Severe over-dredging was performed during the years 1964-1968 in violation of the authority granted by Congress in the Rivers and Harbors Act of 1927, or
5. "Make work" dredging was performed unnecessarily during the years 1964-1968 at mile 208 just to keep equipment busy.

It is simply not credible to maintain that it was necessary to remove two and three-quarter million cubic yards of material at one dredge site on six occurances in a five year period, and then find it unnecessary to remove one grain of sand from that site over the next seven years. (No dredging has been performed here in 1975 either.)

7. Par. 4.2.1.3 Operation and Maintenance of Locks and Dams. Page 182.

A number of references within the DEIS boast that the dams within the study area have created more aquatic habitat than existed prior to the construction of the navigation dams.

DEIS: "Increased recreation potential has resulted due to the greater water surface area within Pools 24, 25 and 26," is stated in Par. 1.3.3.3 (page 10); and "the general effect of operation and maintenance of locks and dams on the aquatic communities of (Navigation) Pools 24,25 and 26... has been quite favorable. The aquatic habitat has been increased both in area and diversity."

Comment: Evidence presented elsewhere in the DEIS, however, does not substantiate the numerous claims. Data exhibited in Table 2-4 reflects

figures of Navigation Pool 25 which were obtained during the Brown Survey and show that there were 22.454 square miles of surface water in 1891, whereas in Chapter 4, Table 4-3, total surface water areas is found to be only 22.562 square miles in 1973 - an increase of slightly over .1 square miles.

The questions which naturally arise to the reader of the DEIS are:

1. Is the data presented in Table 2-4 inaccurate?, or
2. Is the data presented in Table 4-3 inaccurate?, or
3. Is the data presented in both of the above tables inaccurate?, or
4. If both tables contain accurate data, then an increase of .1 square miles over an 83-year period certainly does not appreciably increase aquatic habitat.

Furthermore, extirpation of 18 species of fish from the Illinois River and 8 species from the Upper Mississippi River - at least partially attributed to prevention from upstream migrations due to construction and operation of dams - is not the Sierra Club's impression of "quite favorable" operation and maintenance.

D. Failure to Quantify Environmental Damage.

There has been no attempt to quantify the environmental damage identified in the DEIS The Corps has simply stated that there are certain irretrievable adverse impacts to the environment and has dropped it at that. The Sierra Club feels that studies must be made by the Corps to determine the extent of adverse impact that has occured or will occur if there is continued pool regulation giving specific data - not just in general recognition that there has been environmental damage.

E. Failure to Mitigate the Environmental Damage.

The Corps has not exhibited any determined effort to minimize the adverse impacts, nor are there any specific proposals evaluated within the DEIS that would minimize the environmental damages.

F. Alternatives to the Action.

The DEIS evaluates only three alternatives: that of complete cessation of all O&M activities, that of various locations for dredge disposal, and that of further manipulating pool levels. The disproportionate amount of discussion allocated to cessation of the O&M activities is typical of the scare tactics which have been exhibited by the SLD during other Corps controversies. Cessation of activities is an alternative which must be evaluated under NEPA requirements, but so are other alternatives:

1. Restrict navigational capacity on the waterway. There are finite limits to the extent that the inland waterway system can be expanded without total destruction of the natural resources. Somewhere along the road to blind expansion of navigation, there must be intelligent evaluations on how much we are prepared to sacrifice in terms of environmental degradation.

   One way to minimize further damage would be to set limits on navigational expansion. Just as we have limits on capacity to many things in our lives (e.g. number of people on a bus or an elevator, number of visitors to our National parks), an alternative might be to restrict the numbers of tows to minimize turbidity, danger of collisions, wavewash, water and air pollution, etc.

2. Restriction on the physical sizes of barges should be studied as an alternative action which would minimize resource destruction and reduce O&M effort and expenses. Perhaps reverting back to barge draft

of 6½ feet (rather than planning for expansion to 12 feet) would be a practical alternative to present O&M practices. This aspect should be studied in detail for the Final EIS.

3. Restriction on the physical size and horsepower of pushboats. The steamboats of Mark Twain's day had little effect on the river as compared to the technology of man that is being applied to tugboats today. Larger and greater horsepower tugs are appearing on the Upper Mississippi River. Three boats of 10,500 hp have made their appearance this year and have progressed thru Locks 27 as far upstream as Hartford, Ill. Only the present sill depths at L&D 26 prevent these powerful tugs from invading the Illinois River. There must be a practical size limitation imposed so that turbidity of the river is not quadrupled along with navigation volume.

4. Restriction of navigation on certain days of the week. Navigation continues 24 hours per day without relief. Just as many zoos and natural areas are closed for one day per week to provide relief for the animals, so might a feasible alternative to the O&M be a consideration of restricting navigation for a period of time each week for recovery.

5. Another alternative which might have been considered is the restriction of navigation during certain periods of the year. Cessation of barge traffic during periods of extreme high flows would minimize damage to banks, fields and structures of man. Excessive wavewash is a frequent complaint of river property owners due to inconsiderate barge crews.

Possibly the greatest potential alternative to O&M problems is to restrict navigation during excessive low flows. This would minimize the heavy dredging that must be carried on each year at critical channel

crossovers. During normal flows, water levels can be maintained in the channels to ensure adequate depth so that barges will not "bump" on high spots on the river bottom. Turbidity problems would be minimized during those low flow periods as would the consequences of a serious oil spill during low flows. O&M efforts and costs would be dramatically reduced.

6. In summary of alternatives to O&M action, it should be clear that there other alternatives available to the Corps than those glossed over in the DEIS. The Sierra Club requests a more detailed and thorough examination and study of real alternatives.

CONCLUSION

The Sierra Club notes a number of deficiencies within this DEIS and have concluded that considerable work is necessary to meet the requirements of NEPA. Future impacts are generally ignored by the DEIS and several active Corps projects have been omitted from consideration.

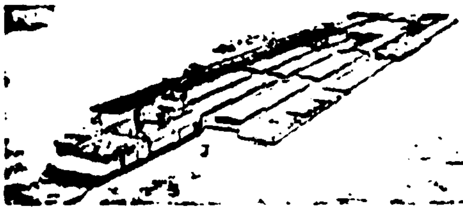
There are considerable specific deficiencies within the DEIS, notably discrepancies of supplied data.

There has been no effort to quantify the adverse environmental impacts.

There has been little effort to mitigate the adverse environmental damage.

Lastly, the DEIS has not made a legitimate attempt at evaluating alternatives to the presently applied O&M activities.

SUMMARY OF TOPICS DISCUSSED



WATERWAYS JOURNAL

Weekly

SINCE 1887

701 CHEMICAL BUILDING
ST. LOUIS, MO 63101

314-241-7354

August 29, 1975

Col. Thorwald R. Peterson
St. Louis District Engineer
210 North 12th Street
St. Louis, MO 63101

Dear Colonel:

We take the liberty of enclosing herewith a statement on the Draft Environmental Statement on the Operation and Maintenance of Pools 24, 25, and 26 on the Mississippi and Illinois Rivers.

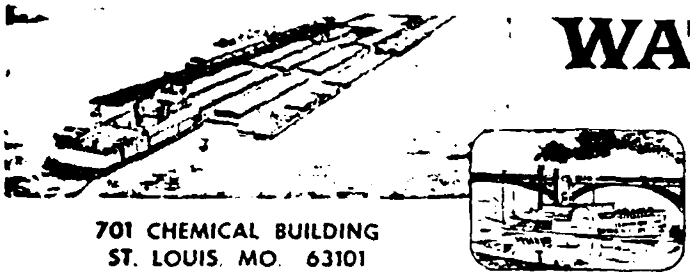
We certainly wish to compliment you and your staff on a very fine presentation, and we feel, as we say in the actual statement, that this is a very satisfactory and comprehensive EIS.

Respectfully,

James V. Swift
Vice-President

JVS/ksc

Enclosure



WATERWAYS JOURNAL
Weekly
SINCE 1887
701 CHEMICAL BUILDING
ST. LOUIS, MO. 63101
314-241-7354

STATEMENT ON THE DRAFT ENVIRONMENTAL
STATEMENT, OPERATION AND MAINTENANCE
POOLS 24, 25, AND 26
MISSISSIPPI AND ILLINOIS RIVERS

August 29, 1975

This statement is presented to the St. Louis District Engineer, Corps of Army Engineers, in response to requests for comments on the Draft Environmental Statement for the operation and maintenance of pools 24, 25, and 26 on the Mississippi and Illinois Rivers.

The Waterways Journal is a weekly publication devoted to commercial marine interests on the inland waterways. We have been publishing since 1887 and are, therefore, very familiar with the needs and problems of the inland waterways marine industry. We appreciate this opportunity to express our views on the Draft Environmental Statement.

We should like to take this opportunity to commend the St. Louis District on the thoroughness of the preparations for this environmental impact statement, and the wide range of organizations and individuals who were contacted by the District prior to the publication of this environmental statement.

In evaluating this statement, we believe it is imperative to remember that in the National Environmental Policy Act, as passed by Congress, language

therein is explicit that a balance should be maintained in the consideration of environmental features between the welfare of nature and man. Nowhere do we read in NEPA that Congress has given governmental agencies the authority to place the human race in "second place" when environmental considerations are made.

In reading this environmental statement, we feel that the proper balance has indeed been kept, and that the statement demonstrates a need for the operation and maintenance of pools 24, 25, and 26.

We conclude that the operation and maintenance of pools 24, 25, and 26, on the Mississippi and Illinois Rivers is necessary for the human environment. An increase in population and industrialization in the next 25 years or more, regardless of the present efforts to achieve a "zero" population plateau, will result in the need of additional transportation facilities. A recent study performed for the United States Maritime Commission by the consulting firm of A. T. Kearney, of Chicago, predicts that inland waterways transportation will double by the year 2000. Based on the statistics for "Waterborne Commerce of the United States," for calendar year 1972, this would mean that 78,367,914 additional tons of freight would move on the Illinois River alone, most of which will pass through some of these pools.

In view of these factors, it would seem that the human environment in the Midwest and South needs the continued operation of these navigation pools to keep down the shipping costs for such vital materials as petroleum products, coal, grain, ores, and iron and steel products--to name a few. Likewise, in a period when balanced trade with foreign countries is of very great importance the price of grain, which is reduced through water transportation, becomes of very great importance to the country's economy.

An evaluation has been made in the environmental statement on the effects on wildlife of the nine-foot navigation project on the upper Mississippi from Alton north to the Twin Cities. It has always impressed us that because of the project a great area has been made habitable for wildlife, especially water birds, due to stable water conditions. Some 194,000 acres of backwater and marshlands were turned over by the Corps to the Bureau of Fish and Wildlife and/or the various states, for wildlife refuges, after the locks and dams were completed.

This, we would say, is a far cry from the days that thousands of fish died each year when the sloughs dried up in late summer and fall along the upper Mississippi. It will be recalled that the Fish Commission of the state of Illinois operated a steamboat to save these fish by moving them from shallow to deep water.

We should now like to address the environmental questions in the report:

Dredge Spoil Disposal--Any change in bank and channel material is going to cause effects on vegetation and organisms. This has been going on for centuries through floods, bank cave-ins, and other natural forces. True, there is a temporary change in what has been coined the "ecosystems," but apparently this has not been too devastating to wildlife inasmuch as there are muskrats, beaver, and amphibians around in 1975, and many fish. Nature takes care of itself.

Noise Pollution--Comments have been made about protecting animals and birds from noise pollution through the elimination of construction of ports and terminals on the the waterways. This would have a devastating effect on the future development of river traffic. Cargos moved by river

must be loaded and unloaded, or there would be no river commerce at all. There are many examples of wildlife living close to industrial facilities, especially on the Gulf Coast. They have adjusted to the noise, just as humans do.

Wave Wash--Various reports that we have seen about the effect of wave wash on animals and fish that nest and breed along the river would indicate that they are intelligent enough to stay out of main channels, and that the wave wash from vessels does not generally reach the sloughs and chutes where these animals would naturally gravitate. We should also like to mention that although recreational craft are often omitted from wave wash reports, indications are that the wave wash from these vessels has more velocity and height than that from commercial vessels.

Fluctuating Water Levels in Pools--We can see no change in the present method of fluctuating water in pools. This process has been going on since the dams were built in the 1930's. It would appear that wildlife has become accustomed to changes in water levels.

Food Chain--Through natural floods and run-offs, the food chain is continually changing on the river bottom and, once again, since this turbidity has been going on for centuries, it would appear the turbidity caused by towboats, operating in the main channels, would have very little effect on the food chain necessary for wildlife. Food necessary for fish and wildlife is in the sloughs, not in the main channels of the river.

Accidents and Spillages--It should be pointed out that the pollution in the water of the Mississippi is due primarily to sewage and chemical wastes from shore, not from boats and barges. If there is one thing we are sure of, it is that the Coast Guard has been most diligent in its efforts to stop pollution on the waterways and that anyone responsible is libel to fines and even imprisonment.

Although it has been stated that secondary impacts from increased traffic on the river would cause problems for wildlife because of increased docking facilities and economic growth in the adjacent areas, it would appear to us the the building of such docks and industrial areas is necessary for the maintenance of the human environment and the welfare of the human race. We should point out that even with a zero population there will be millions of young persons who will need homes, fuel, and food; much material for which is moved by river at a cheap rate and the use of less energy.

Concerning the use of the river for longer periods of time in the winter, therefore resulting in less frozen surface on the water, we would comment that we have seldom seen birds and wildlife hurt by open water, but an icy surface through which they cannot get food could cause them to perish. It would appear that barge traffic, through keeping the river free of ice, would be of great benefit to wildlife, especially birds.

We did notice one error in the Environmental Impact Statement which appeared on page 22. According to our records, the North Western Division declared that a 12-foot channel on the upper Mississippi River above Grafton, Illinois, would be economically unfeasible and asked for no further funds for this study. We believe that the word "ongoing" as used in the Environmental Impact Statement is not correct and may cause some problems in the evaluation of this report by environmental groups and the states of Wisconsin and Minnesota.

However, we again with to commend the St. Louis District for what we consider to be a very adequate and comprehensive EIS on pools 24, 25, and 26.

Respectfully,

James V. Swift
James V. Swift
Vice-President

Enclosures: Copies of newspaper articles indicating the good fishing and recreation available on the upper Mississippi.

THE OHIO RIVER COMPANY
1400-580 BUILDING
CINCINNATI, OHIO 45201
TELEPHONE (513) 721-4000

September 2, 1975

Department of the Army
St. Louis District
Corps of Engineers
210 North 12th Street
St. Louis, Missouri 63101

Attn: Mr. Jack R. Niemi
Chief, Engineering Div.

Subject: (Draft) Environmental Statement, Operations and Maintenance Pools 24, 25 and 26 Mississippi and Illinois Rivers

Reference: LMSED-BA

Dear Sir:

Your subject study in general appears to be adequately extensive in all parts with the exception of Part 6 and in particular catagory (1) "cease all operations and maintenance". The most noticeable omission is the quantum monetary impact by pursuing the cessation of operations and maintenance in Pools 24, 25 and 26 of the Mississippi and Illinois Rivers. Quite frankly, this is not viewed by our industry, nor by reasonable men in other industries as a viable alternative.

The various economic effects suggested do not project their impact by dialogue alone, and should, considering the scope of this study, be weighed by their feasibility and monetary effects. I'm sure you'll agree, the addition of this aspect in your study is mandatory to place alternatives in prospective.

Upon completion of the final draft of this study, The Ohio River Company would appreciate being incorporated on your distribution list.

Respectfully,

C J Santavicca

C. J. Santavicca
Vice President - Engineering

CJS/lc

UNION ELECTRIC COMPANY
1901 GRATIOT STREET
ST. LOUIS, MISSOURI

JOHN K. BRYAN
VICE PRESIDENT
ENGINEERING & CONSTRUCTION

MAILING ADDRESS:
P. O. BOX 149
ST. LOUIS, MISSOURI 63166

August 27, 1975

Mr. Jack R. Niemi
Chief, Engineering Division
Department of the Army
St. Louis District, Corps of Engineers
210 North 12th Street
St. Louis, Missouri 63101

Dear Mr. Niemi:

Reference: LMSED-BA

DRAFT
ENVIRONMENTAL STATEMENT
OPERATION AND MAINTENANCE
POOLS 24, 25, AND 26
MISSISSIPPI AND ILLINOIS RIVERS

We comment as follows on the subject environmental statement received with your July 8, 1975 letter.

Union Electric Company's Sioux Plant which houses two 452 Mw steam-electric generating units is located at river mile 209.5 on Pool 26. The present method of dredge material placement has no effect on the Sioux Plant operation. We would object to any action which blocks the Sioux Plant circulating water intake or discharge canals, or which affects plant operation adversely.

Two of the alternatives to the present action are, cease all operations and maintenance (Section 6.1), and change pool operations (Section 6.3). Discontinuing operation and maintenance would return the river to a natural state. During dry summer periods and low-flow winter periods parts of the river would be dry or extremely shallow. Elimination of Pool 26 would result in loss of cooling water flow and shutdown of Union Electric Company's Sioux Plant, creating a power shortage in the St. Louis area, and in the upper-midwestern region thru the interconnected power system. Similarly, any significant lowering of the regulated pool (Section 6.3) would endanger operation of Sioux Plant.

Very truly yours,

John K. Bryan

WBL

WISCONSIN BARGE LINE, INC.

Phone (618) 254-7458
(314) 741-2902

800 N. DELMAR
HARTFORD, ILLINOIS 62048

August 28, 1975

Colonel Thorwald Peterson, District Engineer
U. S. Army Corps of Engineers, St. Louis District
210 N. 12 St.
St. Louis, MO 63101

Dear Colonel,

I have read the draft Environmental Statement for the operation and maintenance of Pools 24, 25, and 26, Mississippi and Illinois Rivers.

I most heartily endorse the continued dredging and maintenance of the nine foot navigation channel in the pools as enumerated in this draft Environmental Statement. I take this position due to the information and facts which are clearly stated in this Environmental Statement.

In regards to the environment both in relation to marine life and endangered species of mammals, birds, amphibians and reptiles, I find that there isn't any threat to the aforementioned subject. In fact, your dredging in the channel is going to only cause a minimal disturbance, mostly in the terbidity of the water Therefore, I feel that the people who are objecting the dredging and maintenance of the nine foot channel in the St. Louis District in regards to the environment and the wild life species should not be fearful of this maintenance program.

I am most heartily in favor of this maintenance and dredging program because of the economic factors that you present in this Environmental Statement. It is true that the St. Louis District is the connecting link between the Lower Mississippi River, Ohio River, Missouri River and the upper section of the country in which the Upper Mississippi River and the Illinois River are situated. The facts and figures that you present in your Environmental Statement are conclusive proof that water transportation has been an economical boon in many ways to not only the Upper Mississippi River and the Illinois Valley above the St. Louis District, but also has been instrumental in the economic welfare of the southern section of the country below your district.

I wish to compliment you and your staff upon the comprehensive and complete Environmental Statement that you have compiled. It took me a long time to read it but I must say you have been fair and presented all possible aspects to the problem.

Yours truly,

Thomas E. Kenny

Thomas E. Kenny
Marine Superintendent

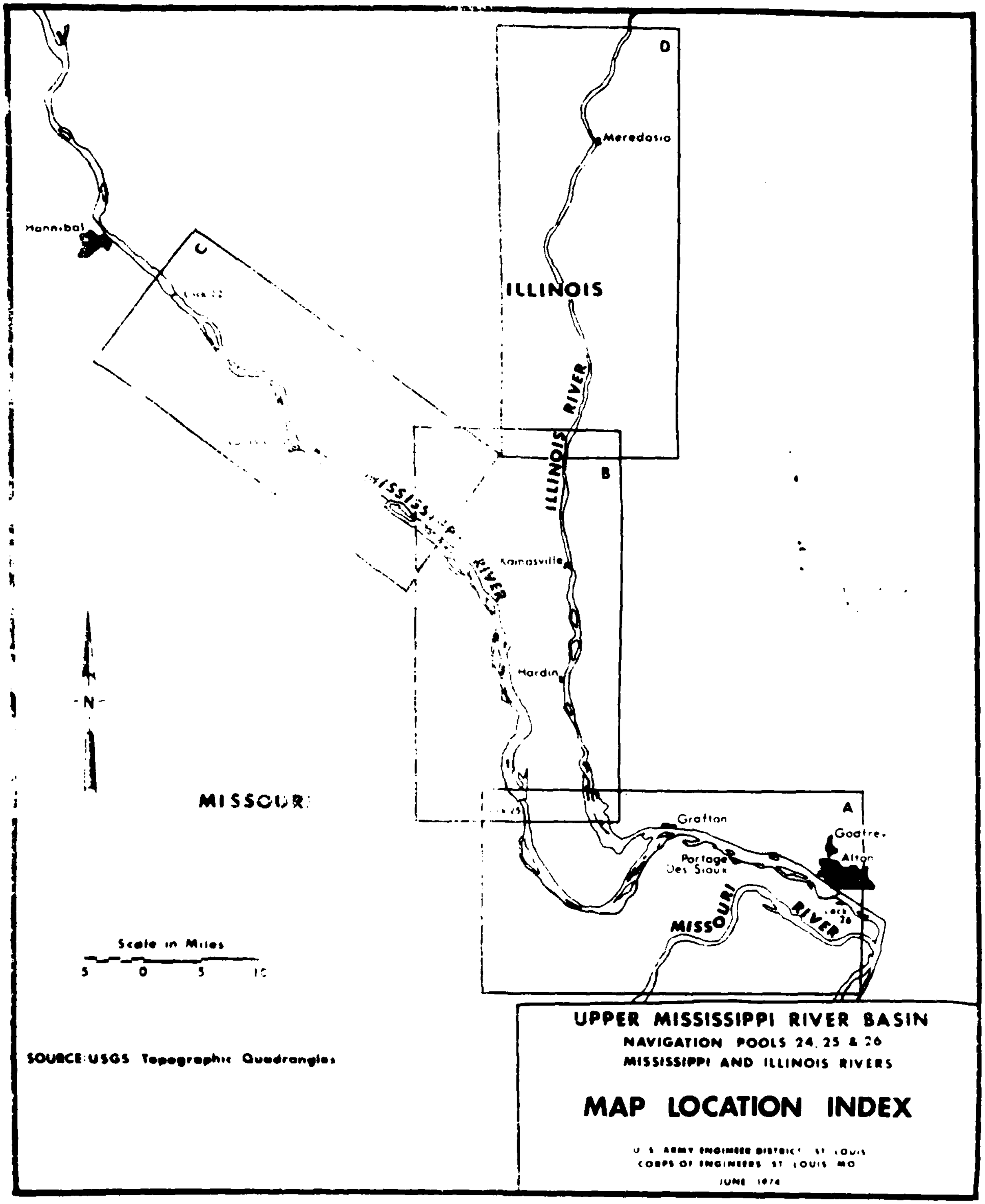
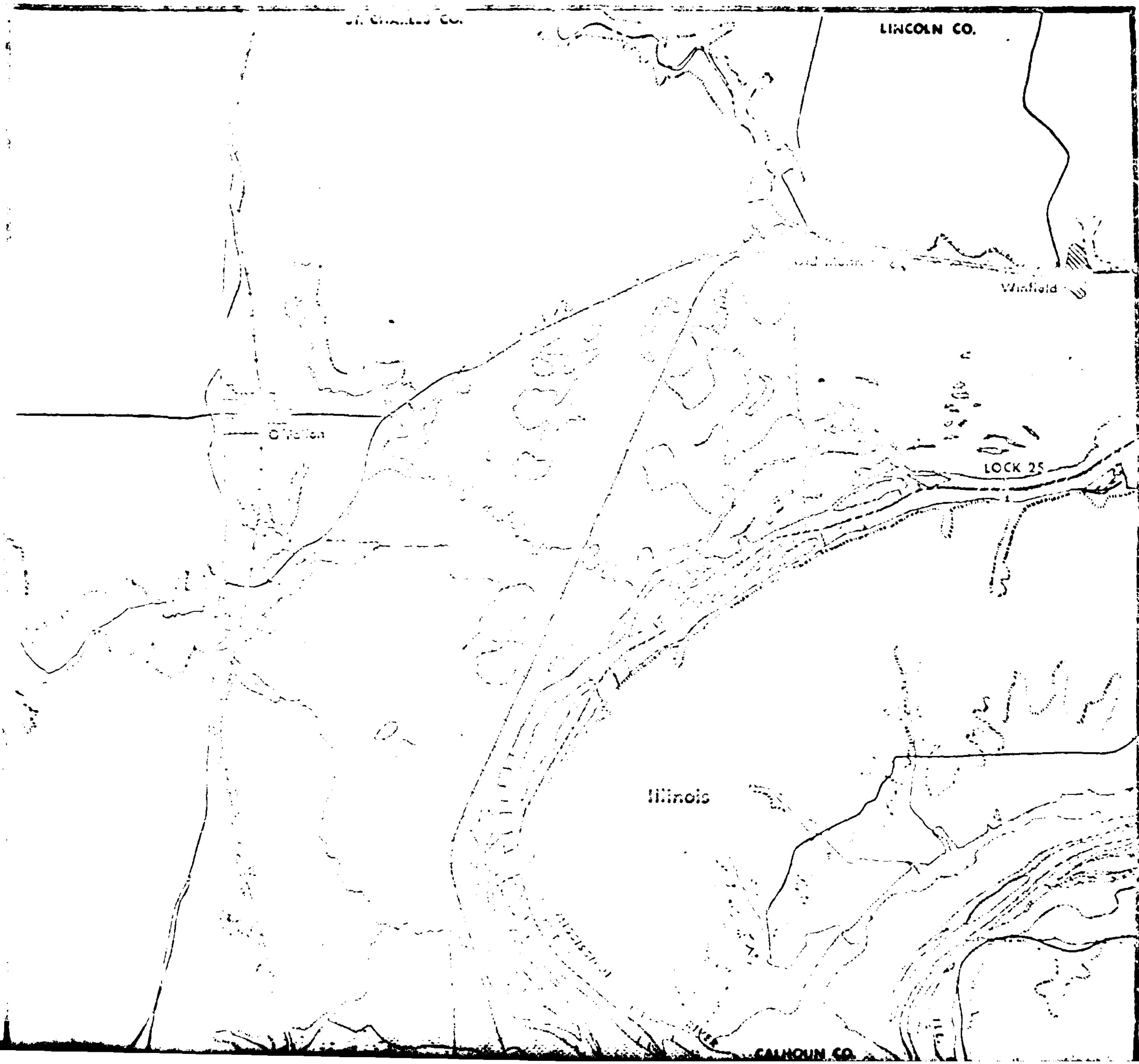

D
Meredosia
Hannibal
C
ILLINOIS
RIVER
ILLINOIS
B
MISSISSIPPI RIVER
Kampsville
Hardin
MISSOURI
A
Grafton
Godfrey
Alton
Portage Des Sioux
MISSOURI RIVER
N
Scale in Miles
5 0 5 10
SOURCE: USGS Topographic Quadrangles
UPPER MISSISSIPPI RIVER BASIN
NAVIGATION POOLS 24, 25 & 26
MISSISSIPPI AND ILLINOIS RIVERS
MAP LOCATION INDEX
U. S. ARMY ENGINEER DISTRICT, ST. LOUIS
CORPS OF ENGINEERS, ST. LOUIS, MO.
JUNE 1974

Plate 1



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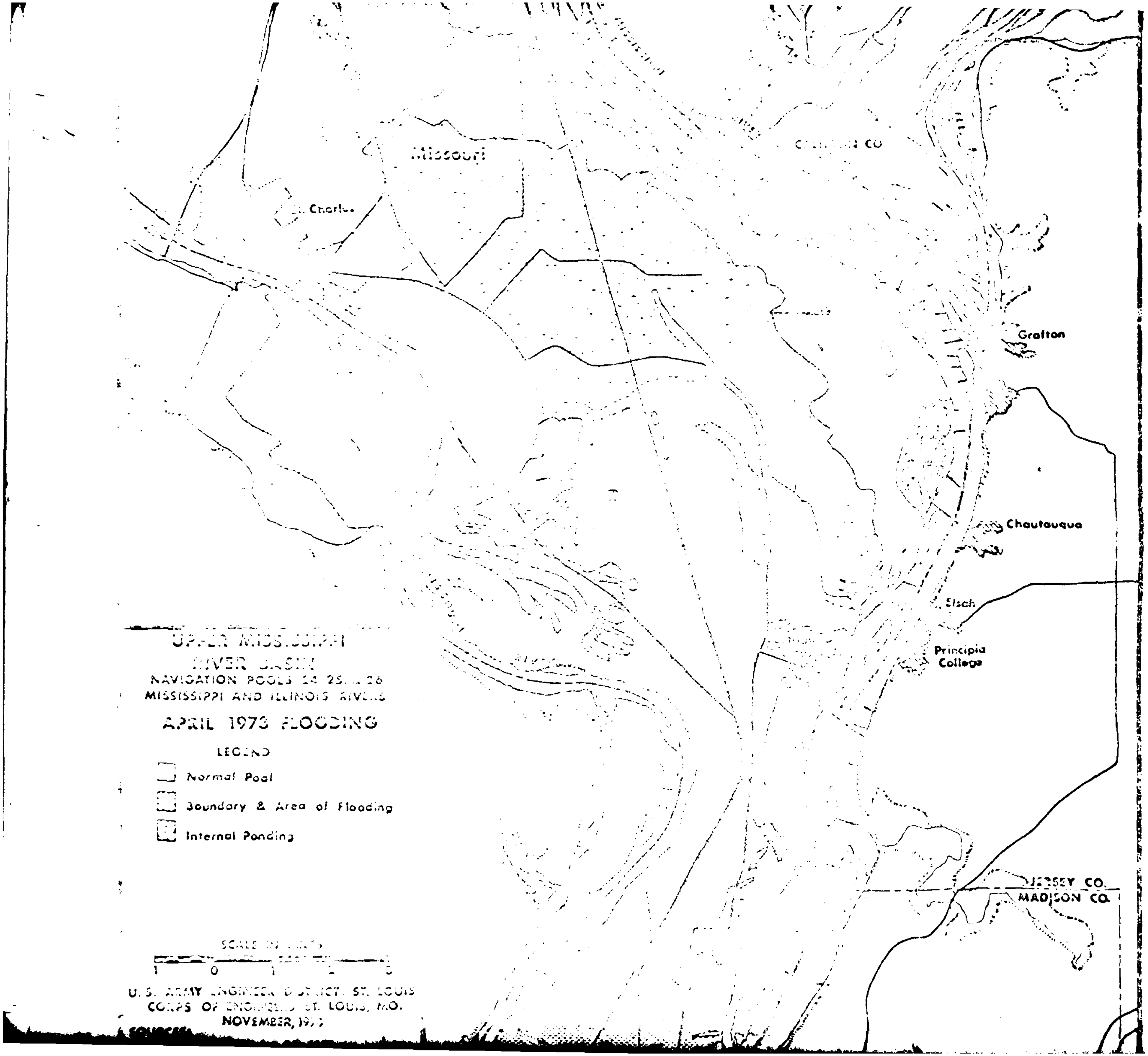
Illinois
CALHOUN CO.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Chautauqua
Elsah
Principia
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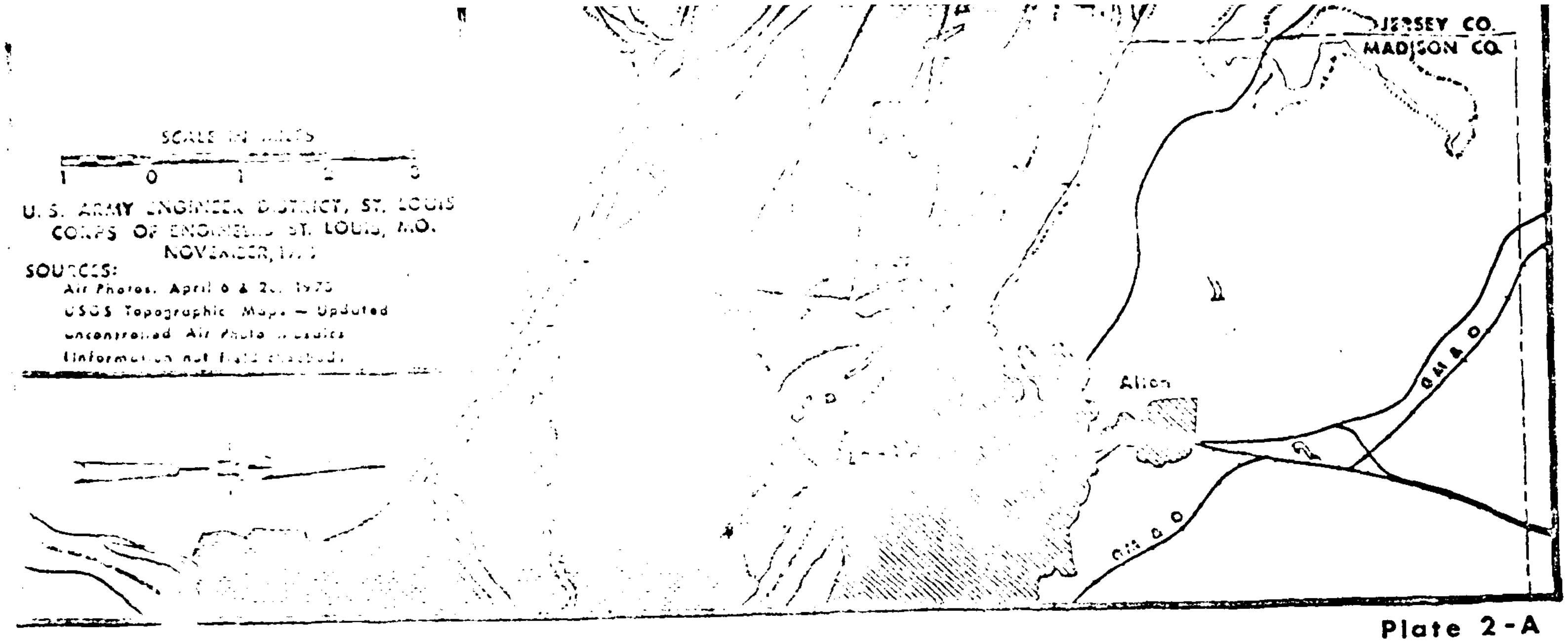
JERSEY CO.
MADISON CO.
APRIL 1973 FLOODING
LEGEND
Normal Pool
Boundary & Area of Flooding
Internal Ponding
NOVEMBER, 197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CORPS OF ENGINEERS ST. LOUIS, MO.
SOURCES:
USGS Topographic Maps — Updated
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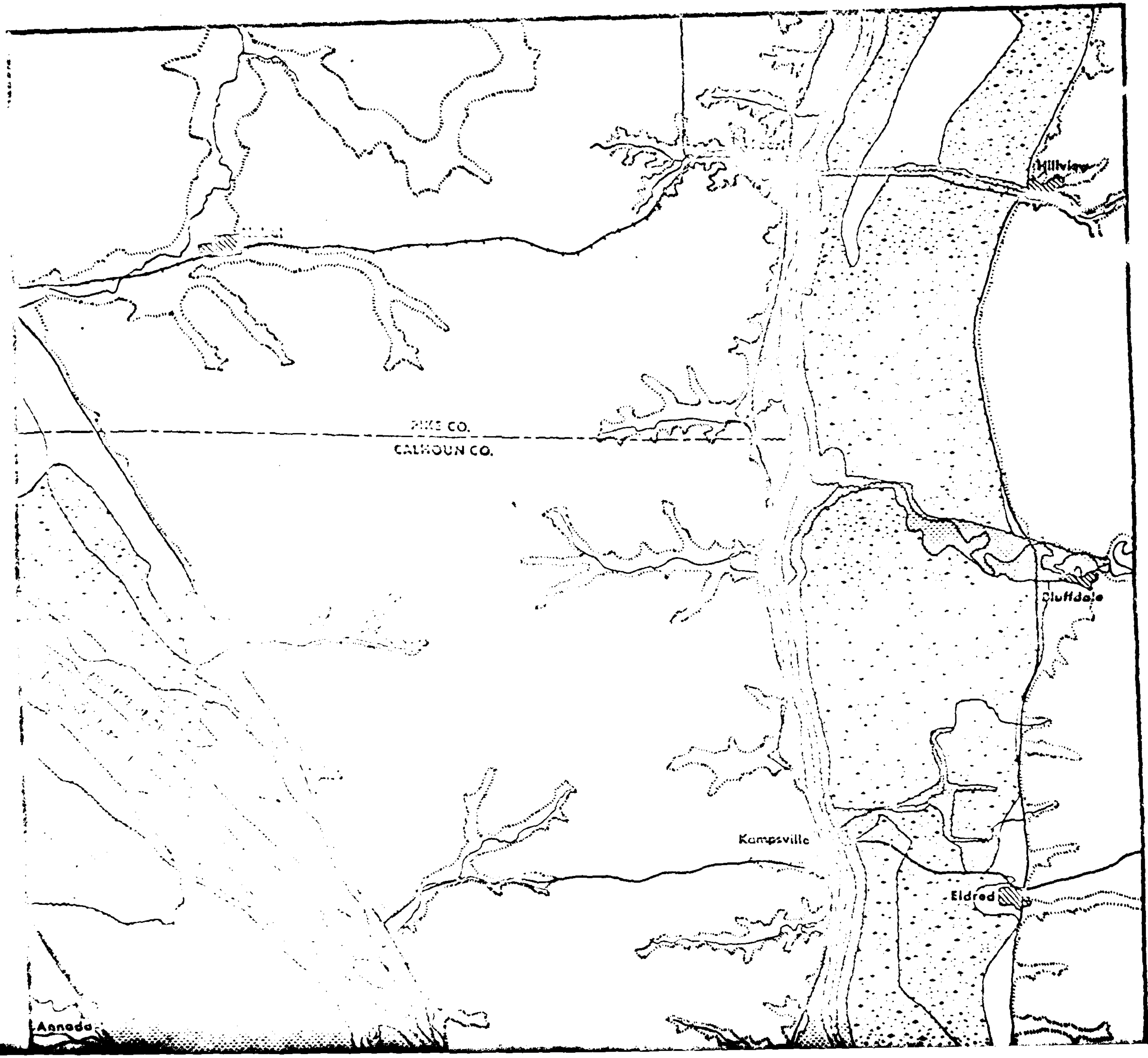
MADISON CO.
Alton
GM & O

Plate 2-A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Kampsville
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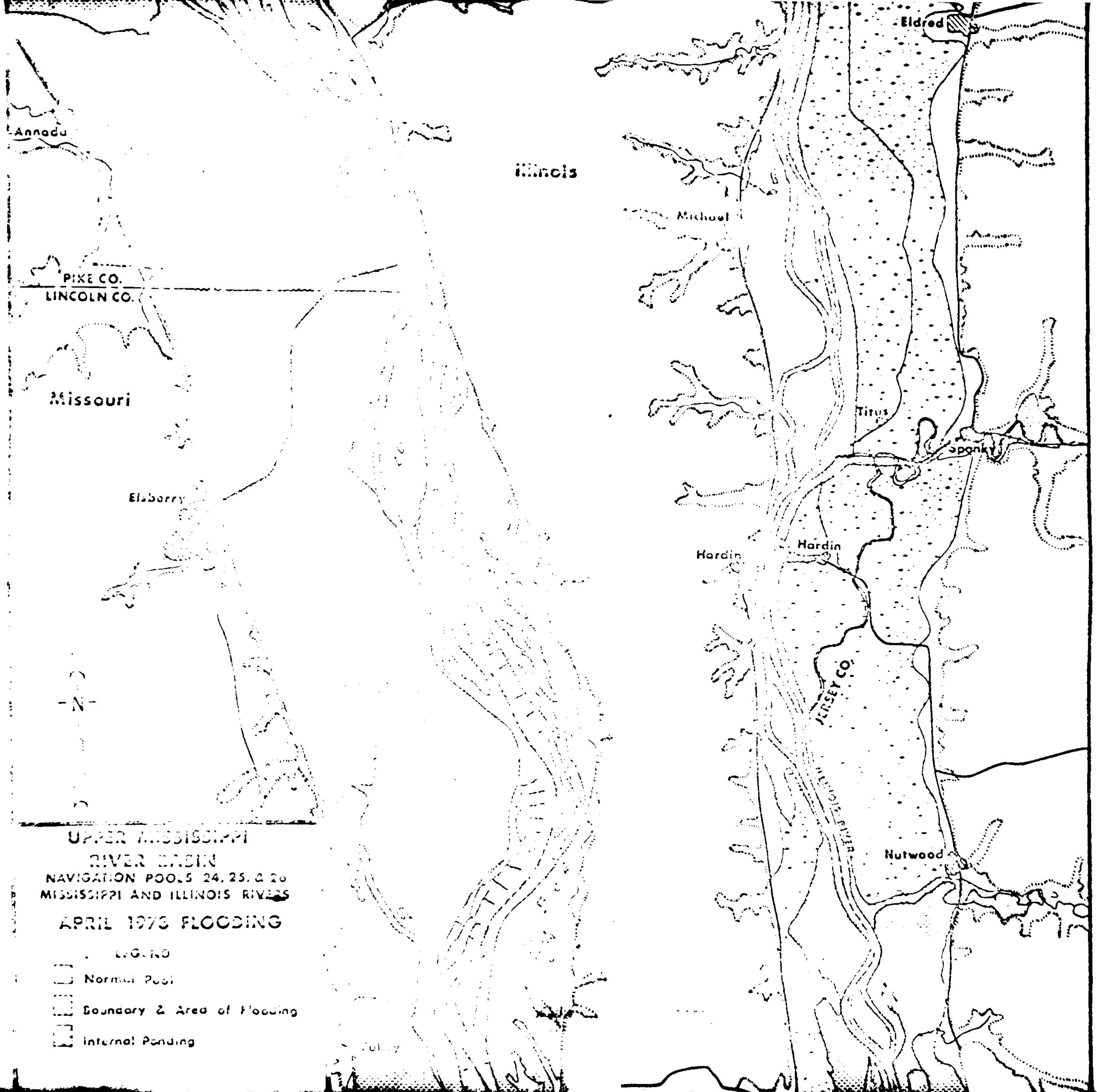
Annada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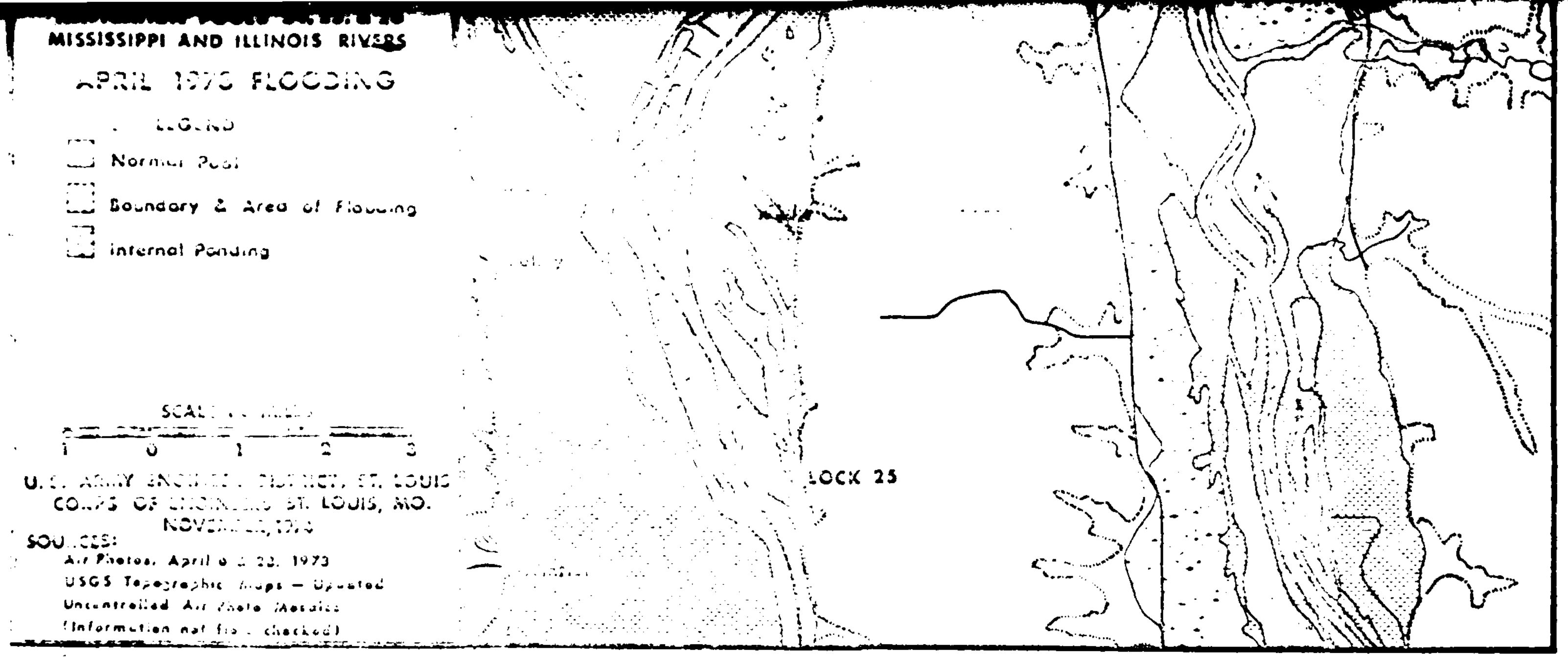
Annada
Illinois
Michael
PIKE CO.
LINCOLN CO.
Missouri
Titus
Spanky
Elsberry
Hardin
Hardin
JERSEY CO.
ILLINOIS RIVER
Nutwood
N
UPPER MISSISSIPPI
RIVER BASIN
NAVIGATION POOLS 24, 25, & 26
MISSISSIPPI AND ILLINOIS RIVERS
APRIL 1973 FLOODING
LEGEND
Normal Pool
Boundary & Area of Flooding
Internal Ponding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APRIL 1973 FLOODING
Normal Pool
Boundary & Area of Flooding
Internal Ponding
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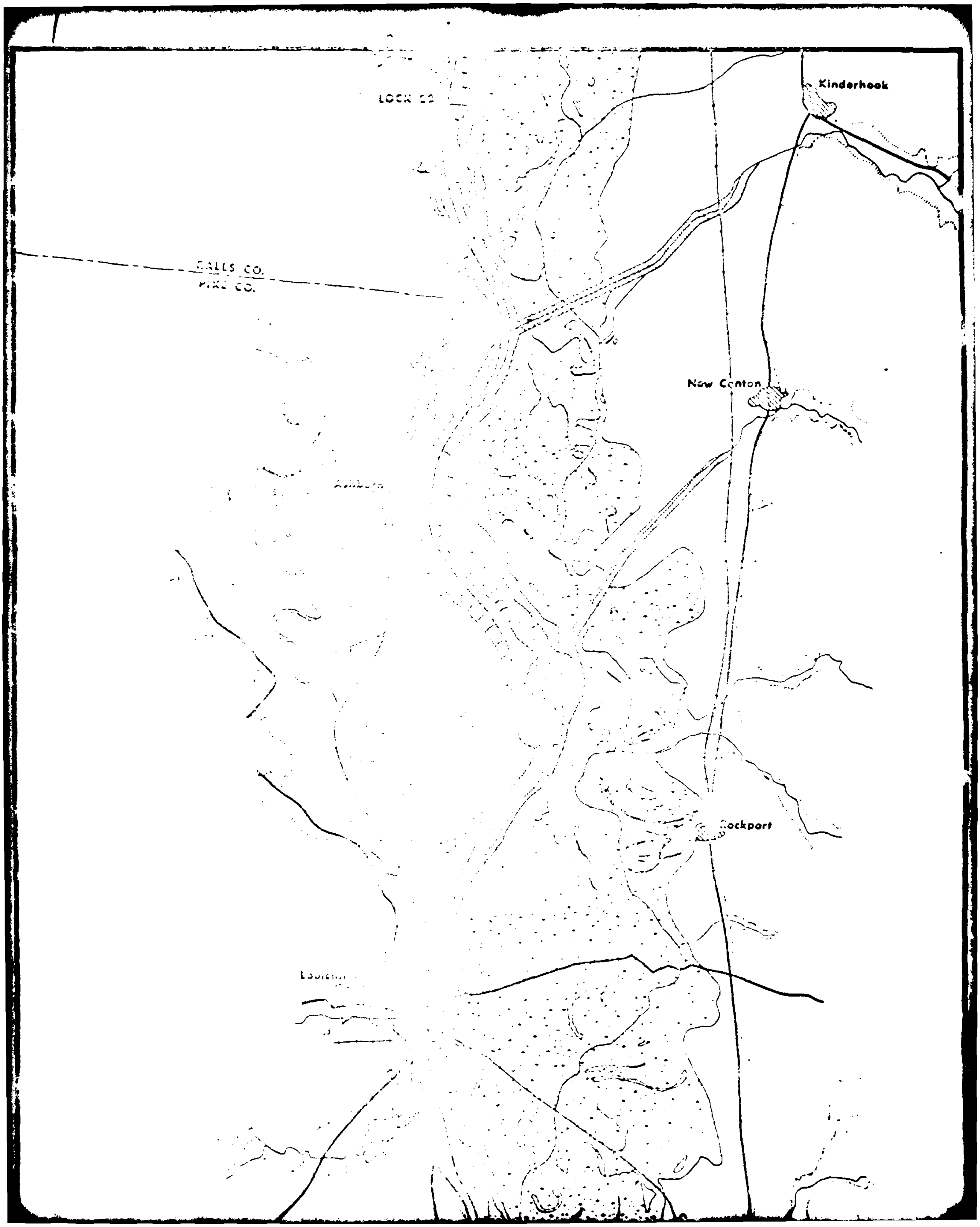
CORPS OF ENGINEERS ST. LOUIS, MO.
Air Photos, April 6 & 23, 1973
USGS Topographic Maps — Updated
LOCK 25

Plate 2-B



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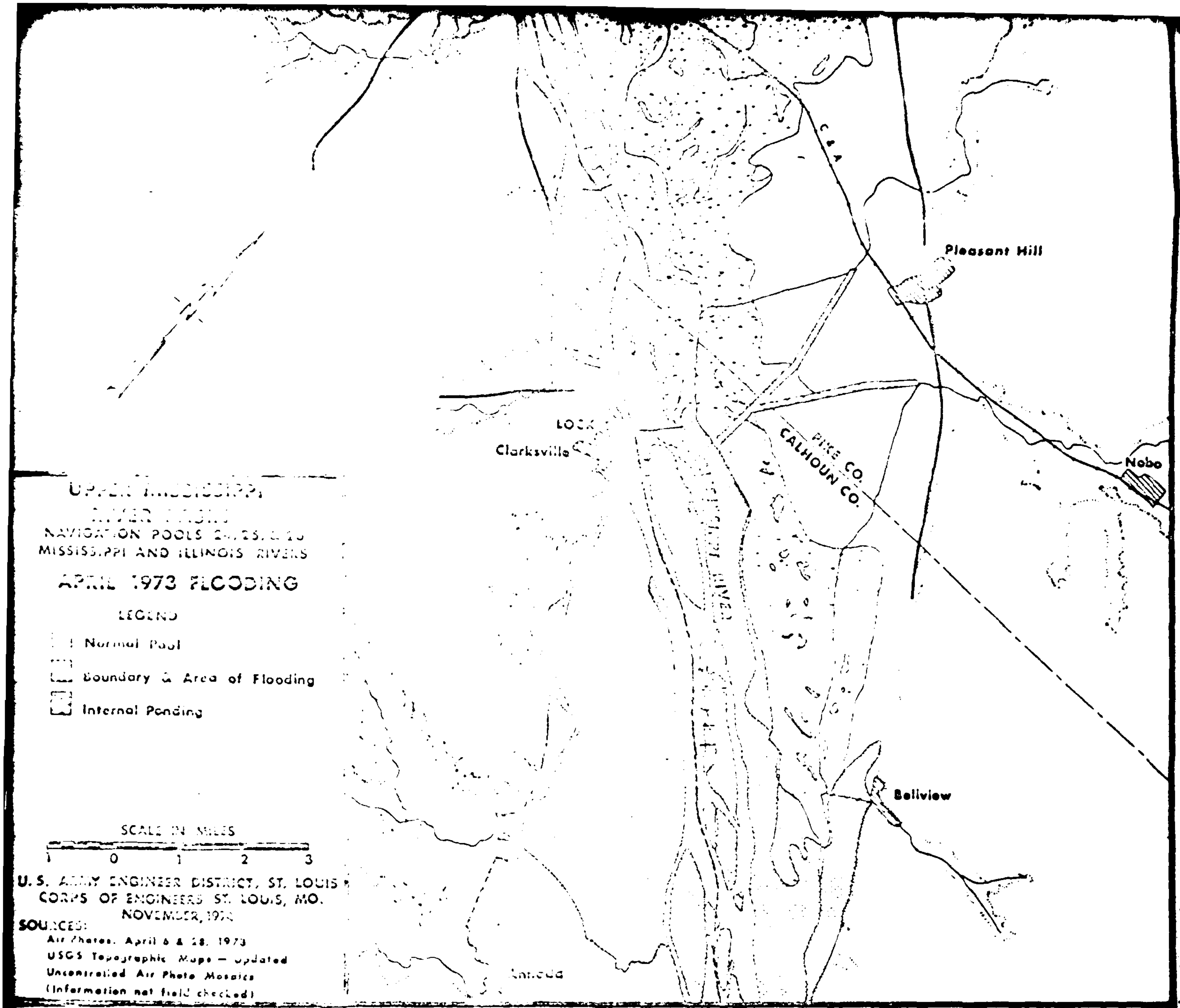
PIKE CO.
New Canton
Rockport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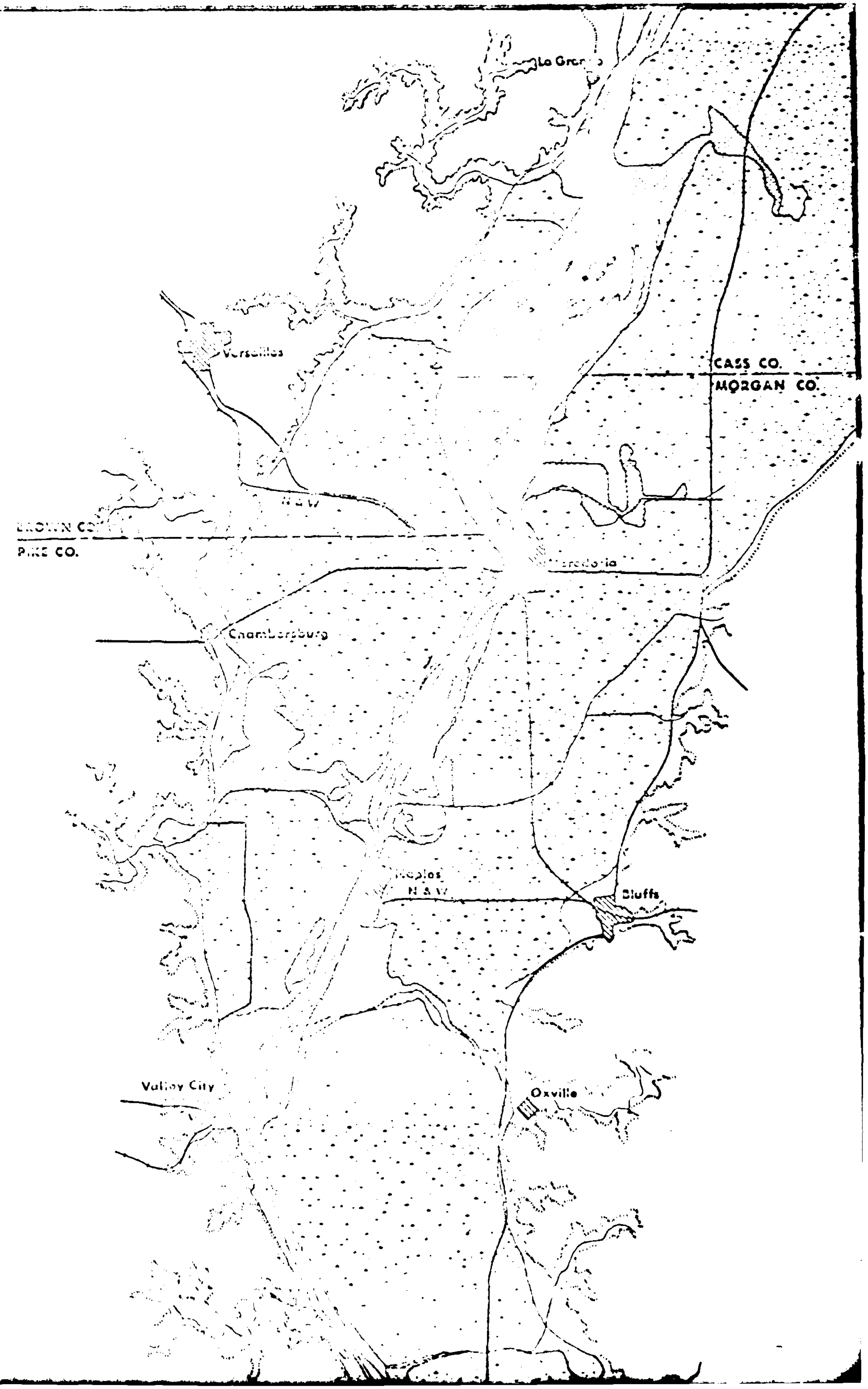
LOCK
Clarksville
PIKE CO.
CALHOUN CO.
Nobo
Bellview
MISSISSIPPI AND ILLINOIS RIVERS
APRIL 1973 FLOODING
LEGEND
Normal Pool
Boundary & Area of Flooding
Internal Ponding
SCALE IN MILES
1 0 1 2 3
U.S. ARMY ENGINEER DISTRICT, ST. LOUIS
CORPS OF ENGINEERS ST. LOUIS, MO.
SOURCES:
Air Photos, April 6 & 28, 1973
USGS Topographic Maps — updated
Uncontrolled Air Photo Mosaics
(Information not field checked)

Plate 2-C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CASS CO.
MORGAN CO.
N & W
PIKE CO.
Chambersburg
N & W
Bluffs
Valley City
Oxville

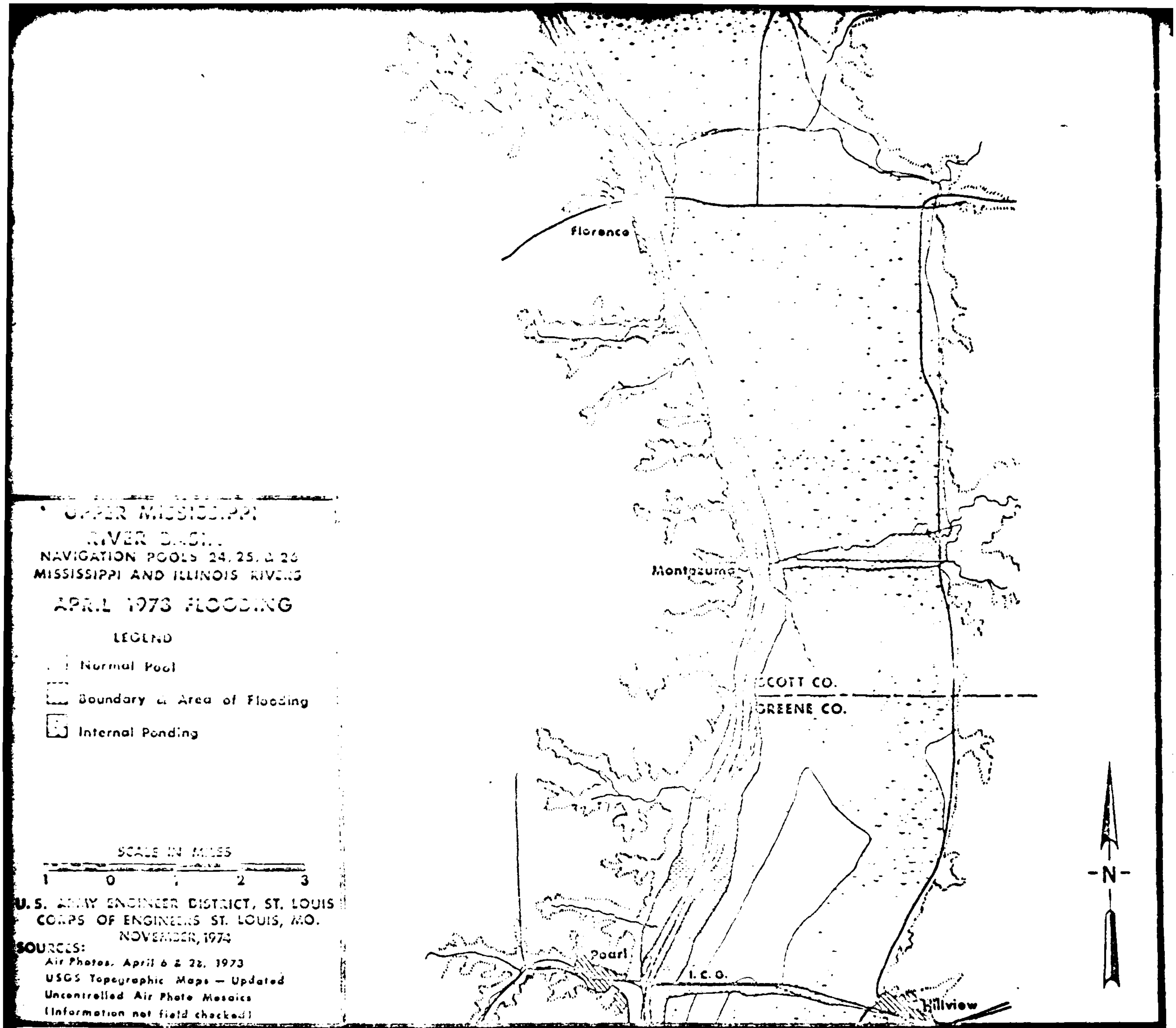
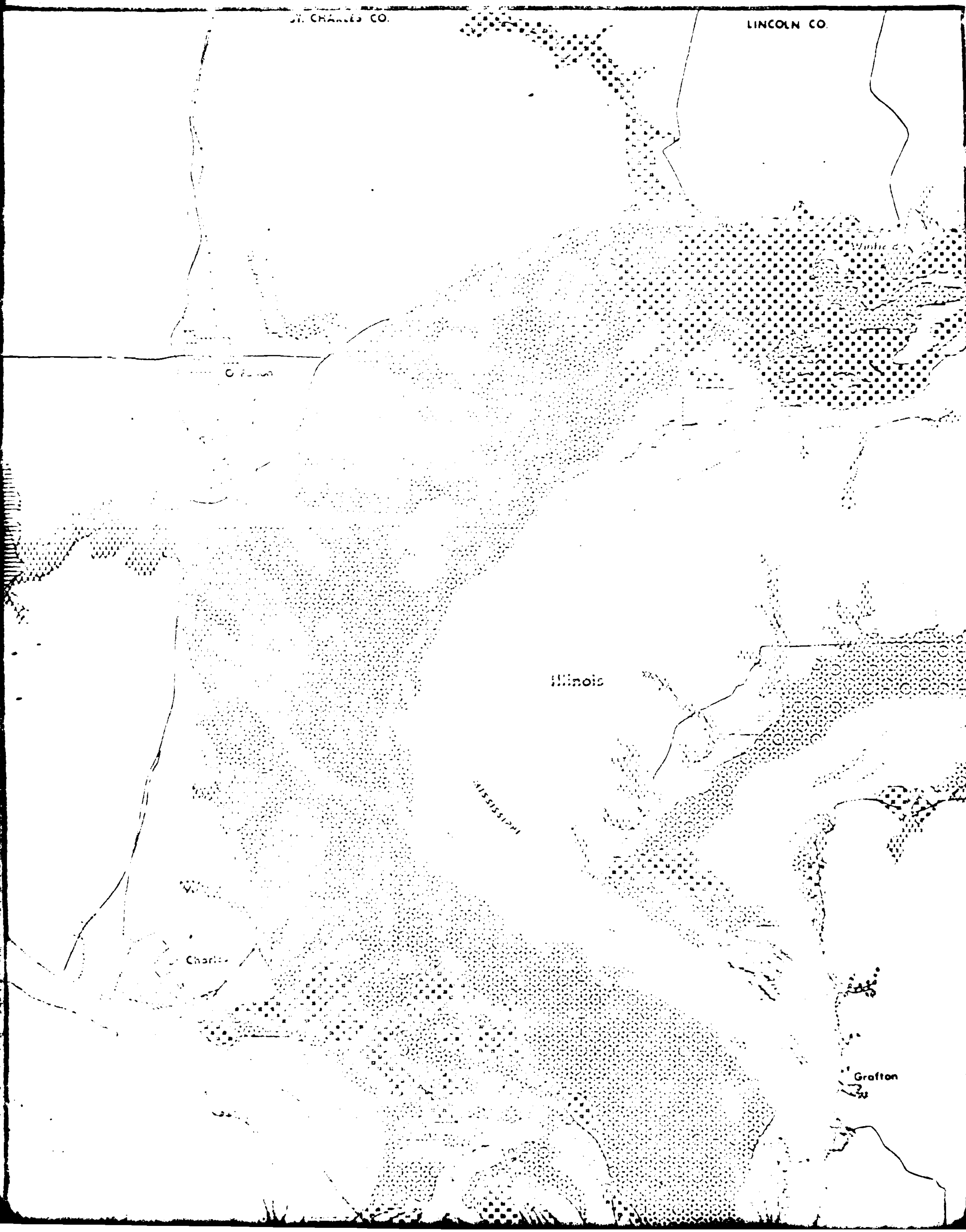

NAVIGATION POOLS 24, 25, & 26
MISSISSIPPI AND ILLINOIS RIVERS
APRIL 1973 FLOODING
LEGEND
Normal Pool
Boundary of Area of Flooding
Internal Ponding
SCALE IN MILES
1 0 1 2 3
U.S. ARMY ENGINEER DISTRICT, ST. LOUIS
CORPS OF ENGINEERS ST. LOUIS, MO.
NOVEMBER, 1974
SOURCES:
Air Photos, April 6 & 22, 1973
USGS Topographic Maps — Updated
Uncontrolled Air Photo Mosaics
(Information not field checked)
Florence
Montezuma
SCOTT CO.
GREENE CO.
Pearl
I.C.G.
Hillview
N

Plate 2-D


LINCOLN CO.
Illinois
Grafton

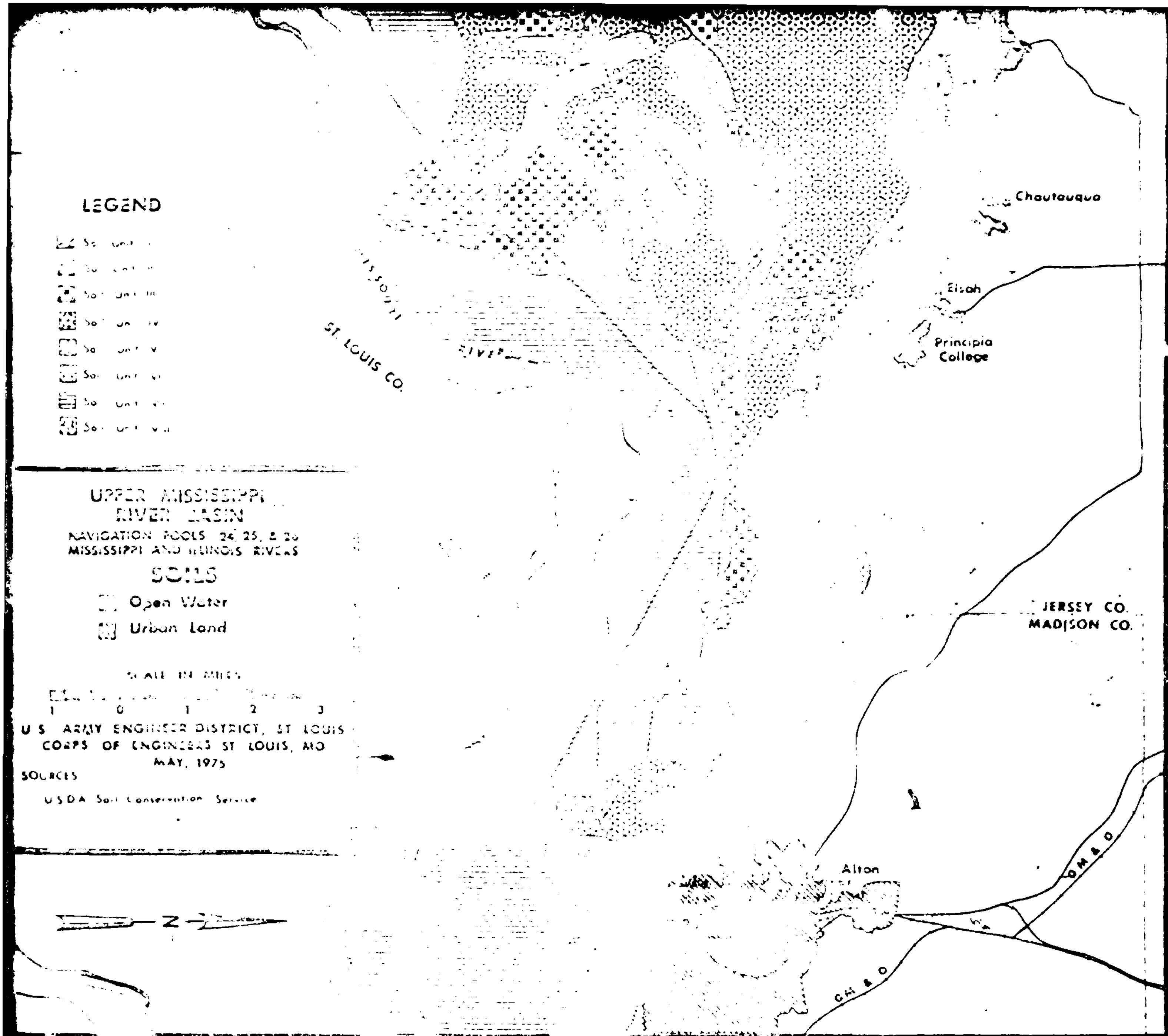
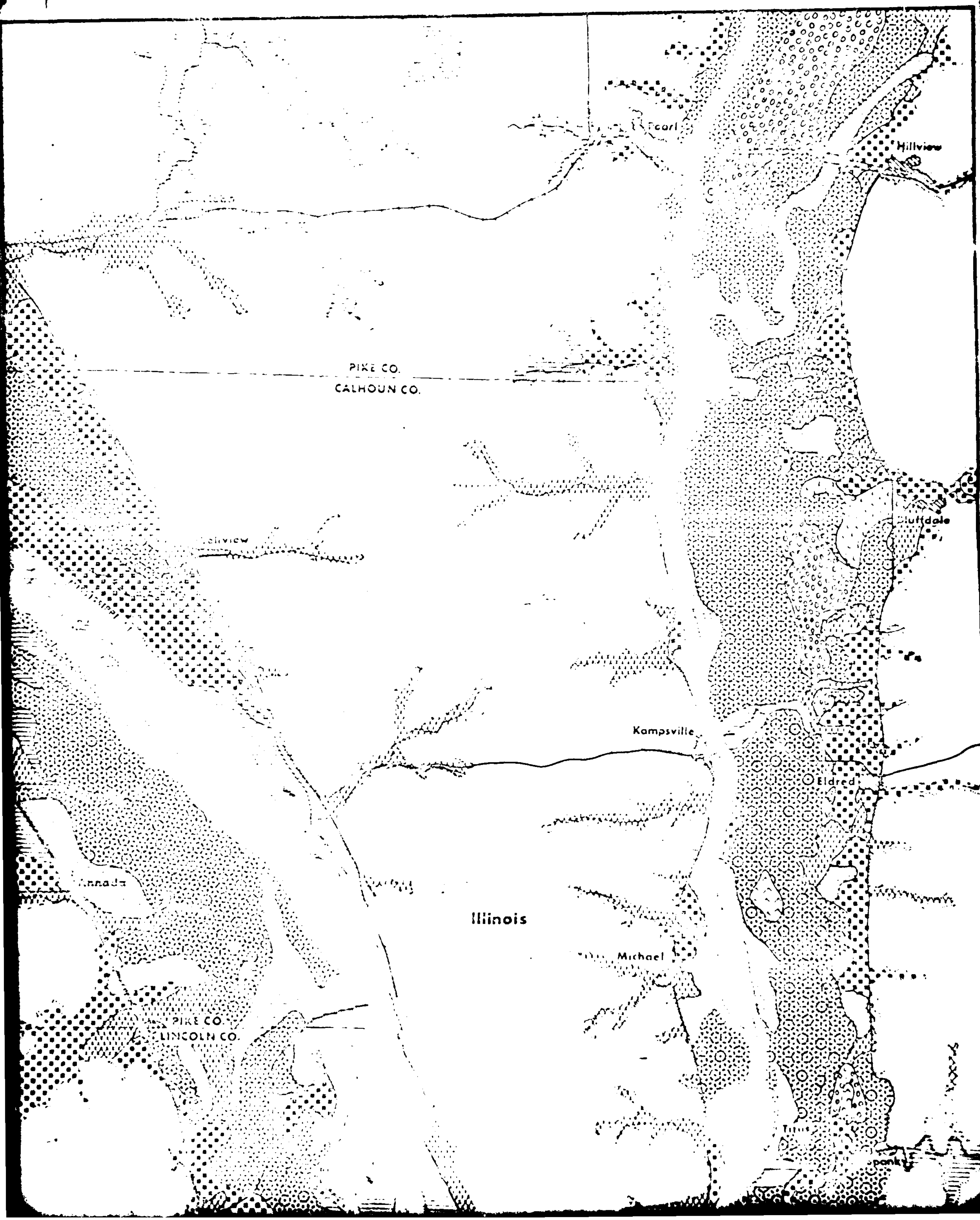

LEGEND
UPPER MISSISSIPPI
RIVER BASIN
NAVIGATION POOLS 24, 25, & 26
MISSISSIPPI AND ILLINOIS RIVERS
SOILS
Open Water
Urban Land
SCALE IN MILES
1 0 1 2 3
U.S. ARMY ENGINEER DISTRICT, ST. LOUIS
CORPS OF ENGINEERS ST. LOUIS, MO
MAY, 1975
SOURCES
U.S.D.A. Soil Conservation Service
N
ST. LOUIS CO.
Chautauqua
Elsah
Principia
College
JERSEY CO.
MADISON CO.
Alton
GM & O

PLATE 3-A


Pearl
Hillview
PIKE CO.
CALHOUN CO.
Kampsville
Eldred
Illinois
Michael
PIKE CO.
LINCOLN CO.

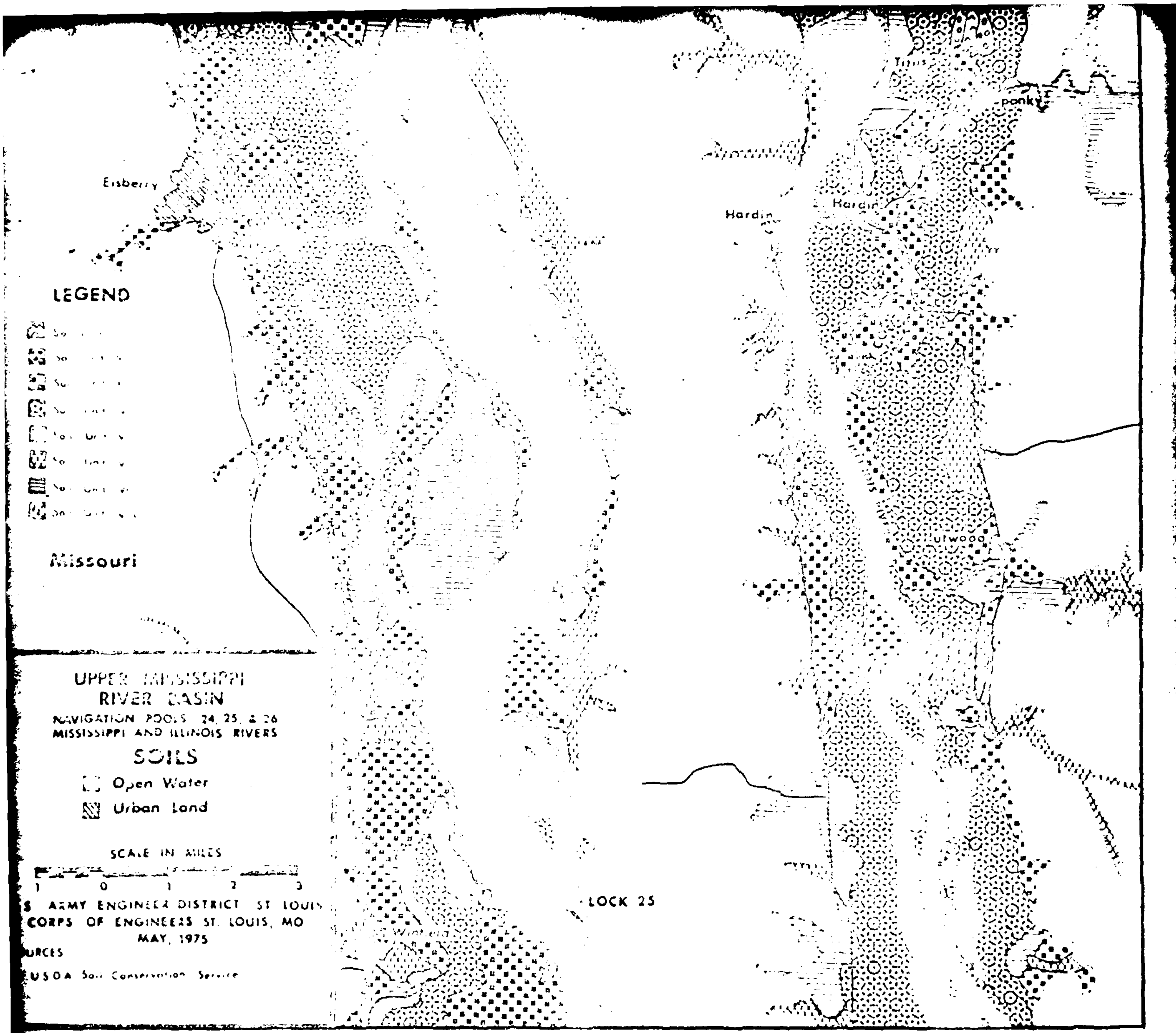
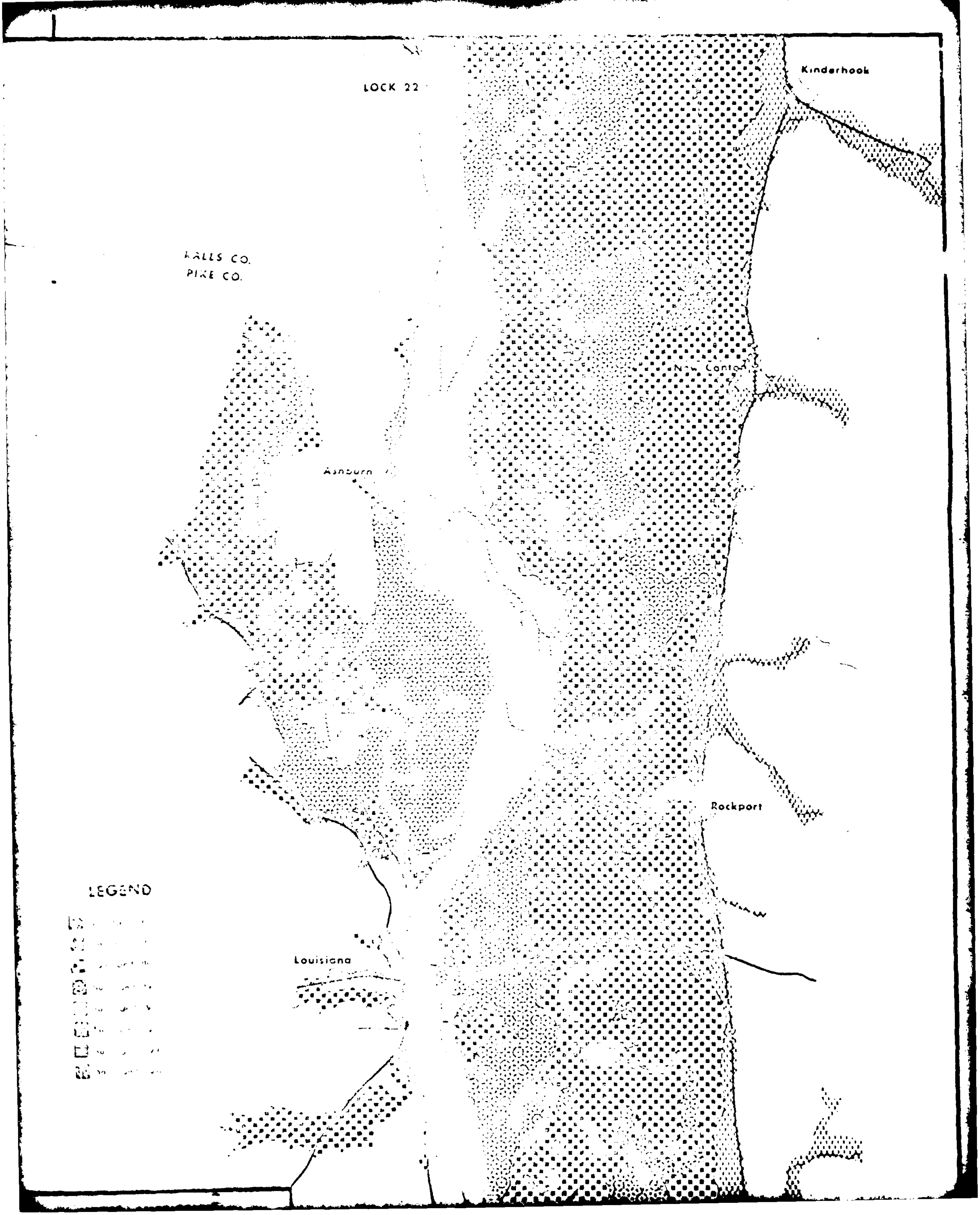
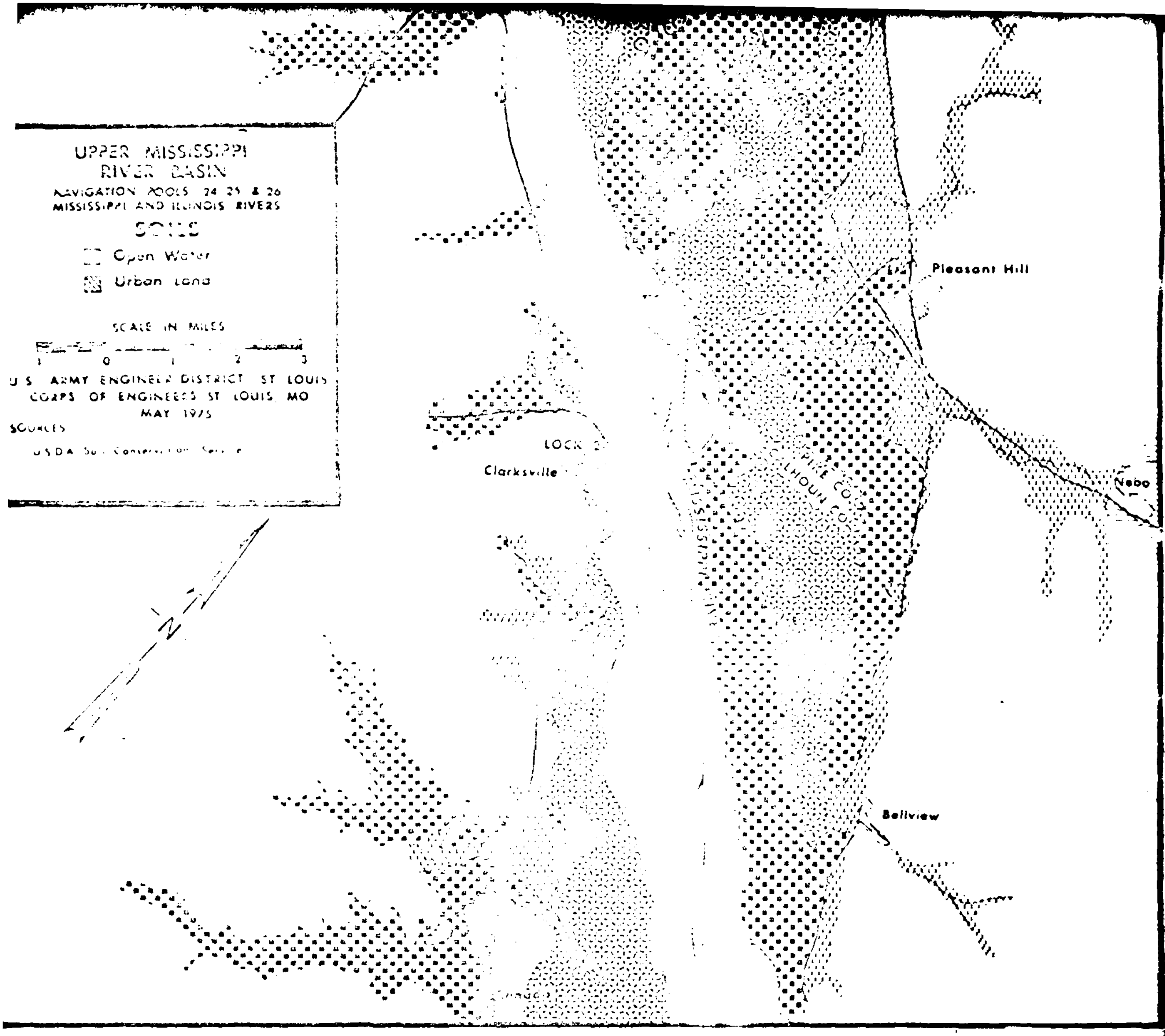

Elsberry
Hardin
Hardin
LEGEND
Missouri
UPPER MISSISSIPPI
RIVER BASIN
NAVIGATION POOLS 24, 25, & 26
MISSISSIPPI AND ILLINOIS RIVERS
SOILS
Open Water
Urban Land
SCALE IN MILES
1 0 1 2 3
LOCK 25
ARMY ENGINEER DISTRICT ST LOUIS
CORPS OF ENGINEERS ST. LOUIS, MO
MAY, 1975
URCES
U.S.D.A. Soil Conservation Service

PLATE 3-B

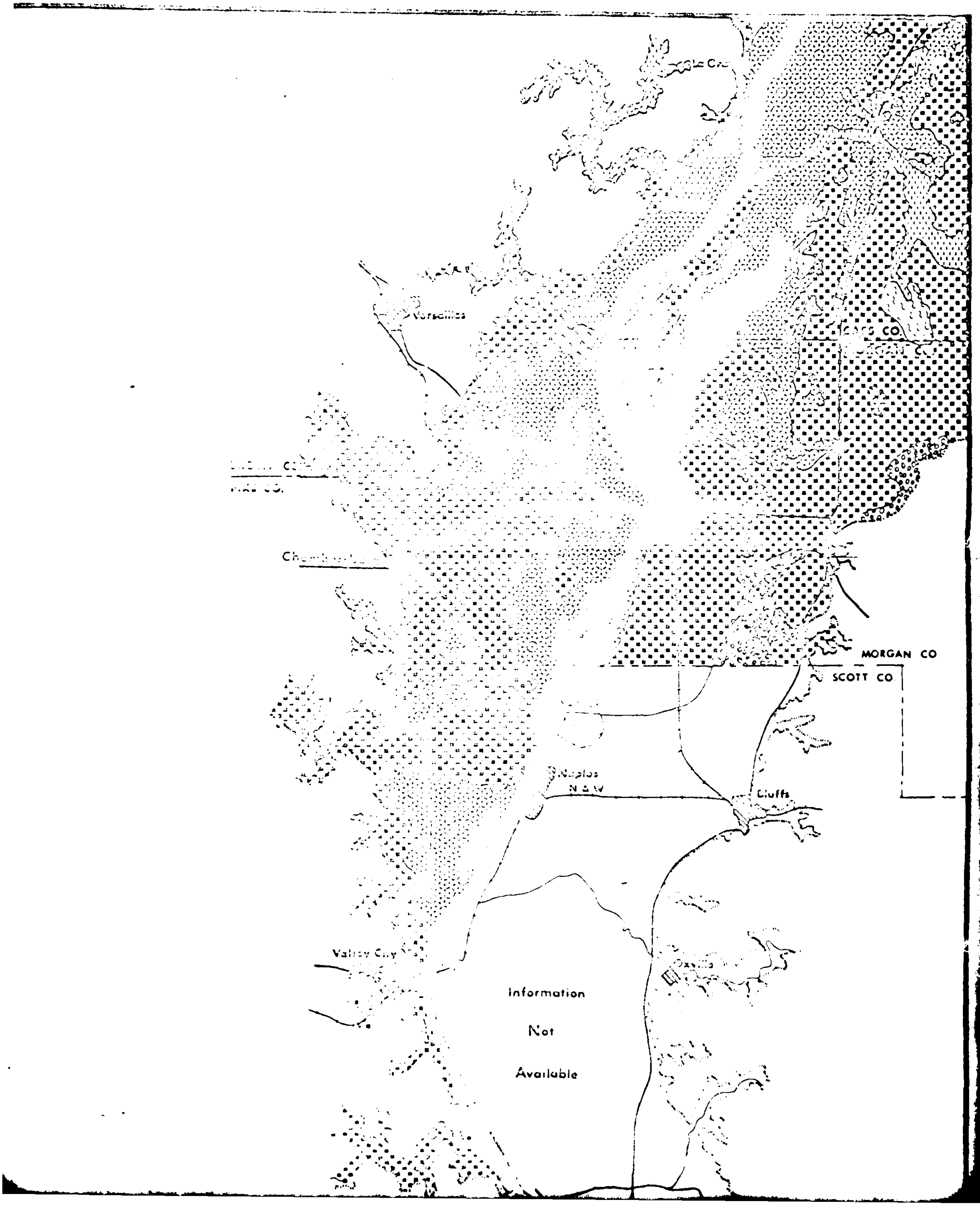


LOCK 22
Kinderhook
RALLS CO.
PIKE CO.
New Canton
Ashburn
Rockport
LEGEND
Louisiana



UPPER MISSISSIPPI
RIVER BASIN
NAVIGATION POOLS 24 25 & 26
MISSISSIPPI AND ILLINOIS RIVERS
SOILS
Open Water
Urban Land
SCALE IN MILES
1 0 1 2 3
U S ARMY ENGINEER DISTRICT ST LOUIS
CORPS OF ENGINEERS ST LOUIS MO
MAY 1975
SOURCES
USDA Soil Conservation Service
N
Pleasant Hill
LOCK 24
Clarksville
PIKE CO
CALHOUN CO
Nebo
Bellview

PLATE 3-C


Versailles
MORGAN CO
SCOTT CO.
Naples
Bluffs
Valley City
Oxville
Information
Not
Available

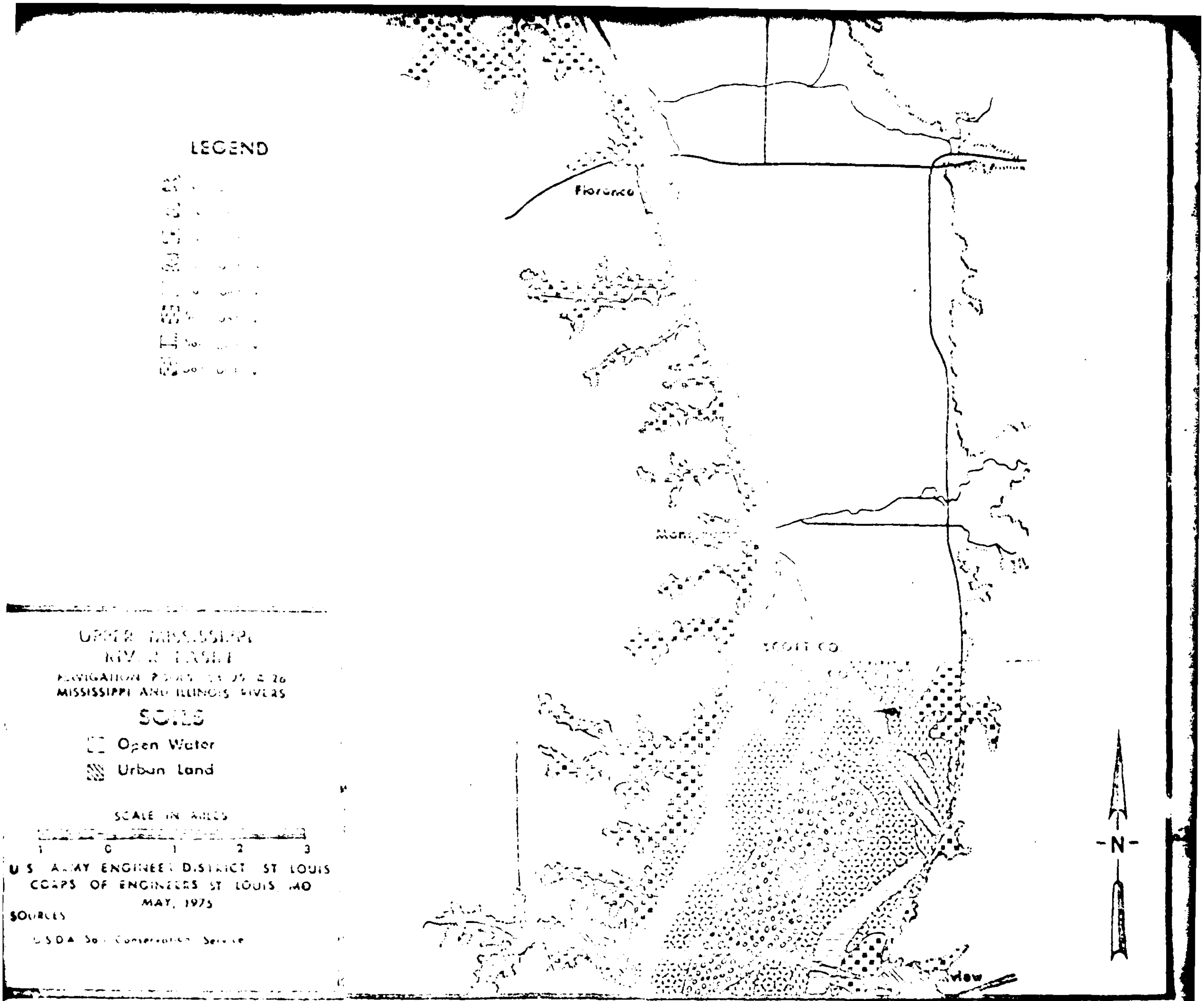
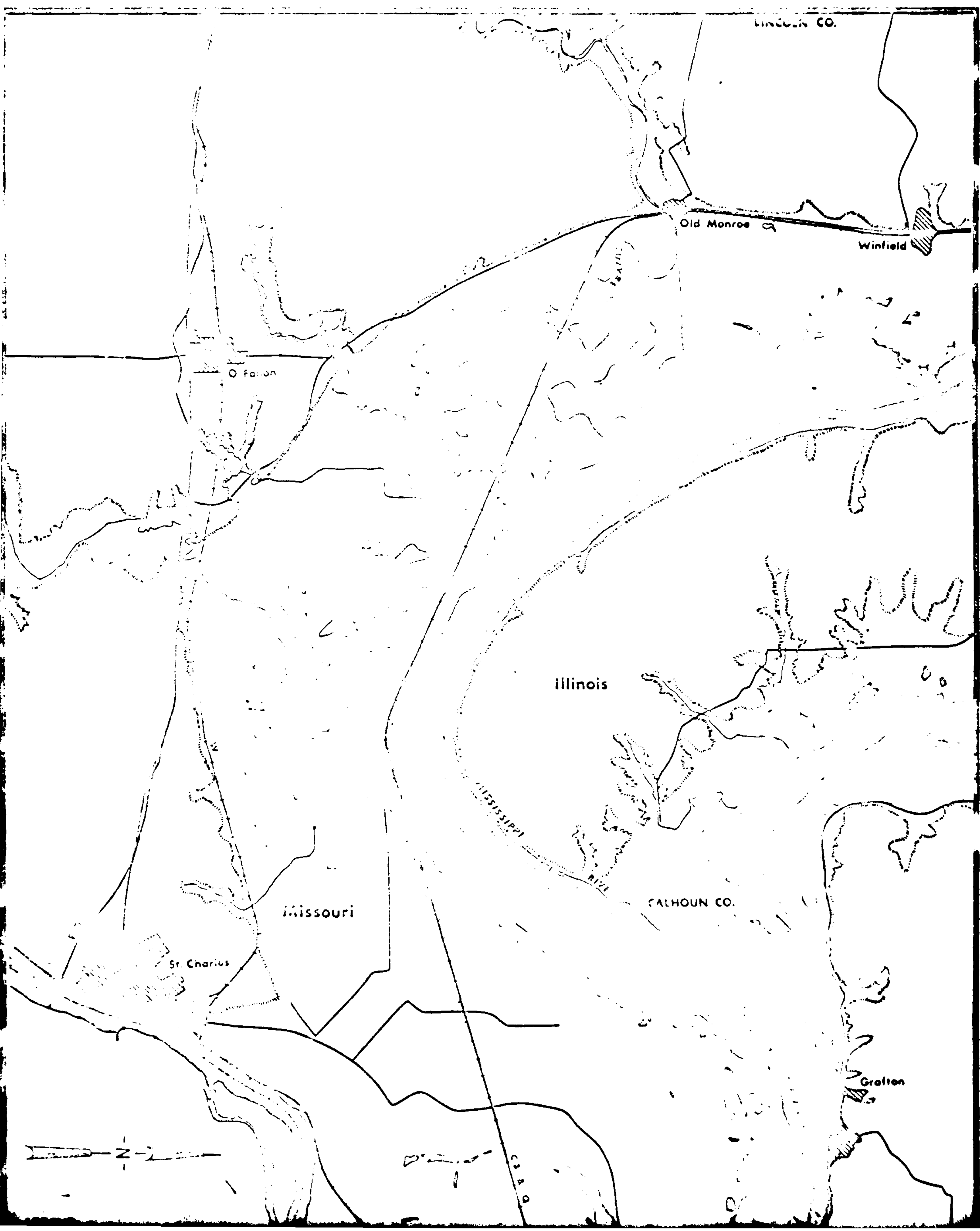

LEGEND
Florence
SCOTT CO.
UPPER MISSISSIPPI
RIVER BASIN
NAVIGATION POOLS 24 25 & 26
MISSISSIPPI AND ILLINOIS RIVERS
SOILS
Open Water
Urban Land
SCALE IN MILES
1 0 1 2 3
U.S. ARMY ENGINEER DISTRICT ST LOUIS
CORPS OF ENGINEERS ST LOUIS MO
MAY, 1975
SOURCES
USDA Soil Conservation Service
N

PLATE 3-D



LINCOLN CO.
Old Monroe
Winfield
O'Fallon
Illinois
MISSISSIPPI
RIVER
CALHOUN CO.
Missouri
St. Charles
Grafton
N
CB & Q

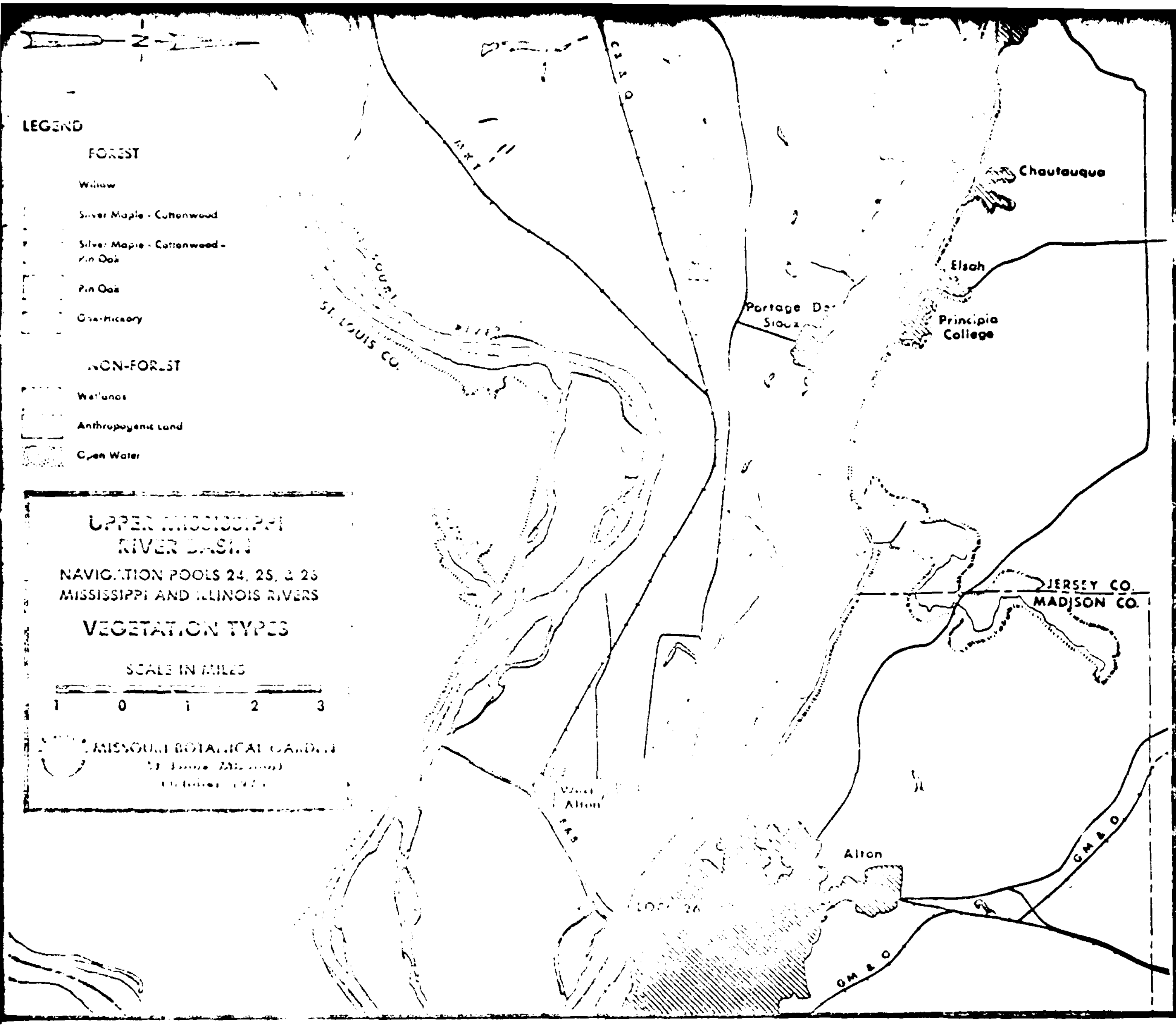
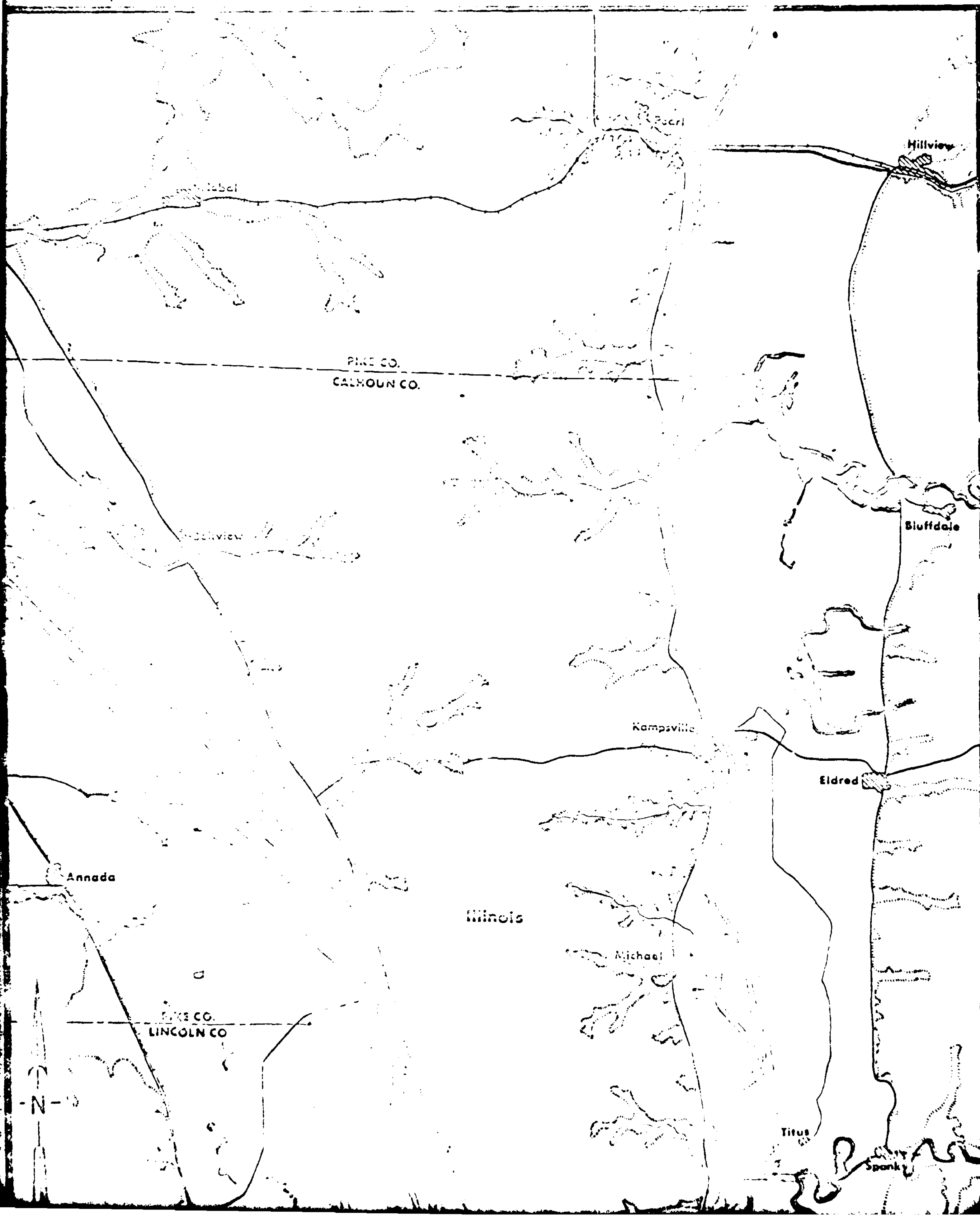
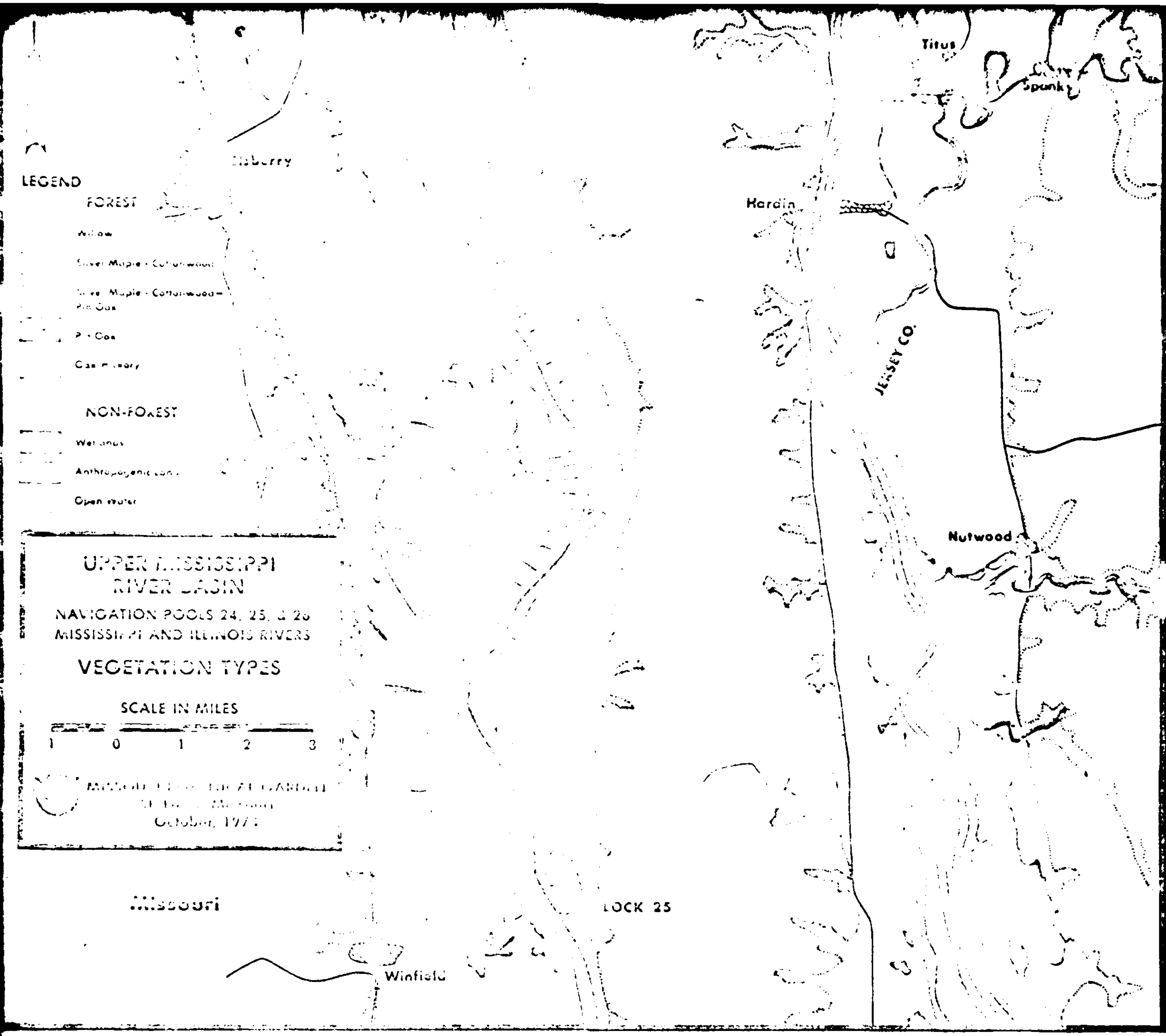
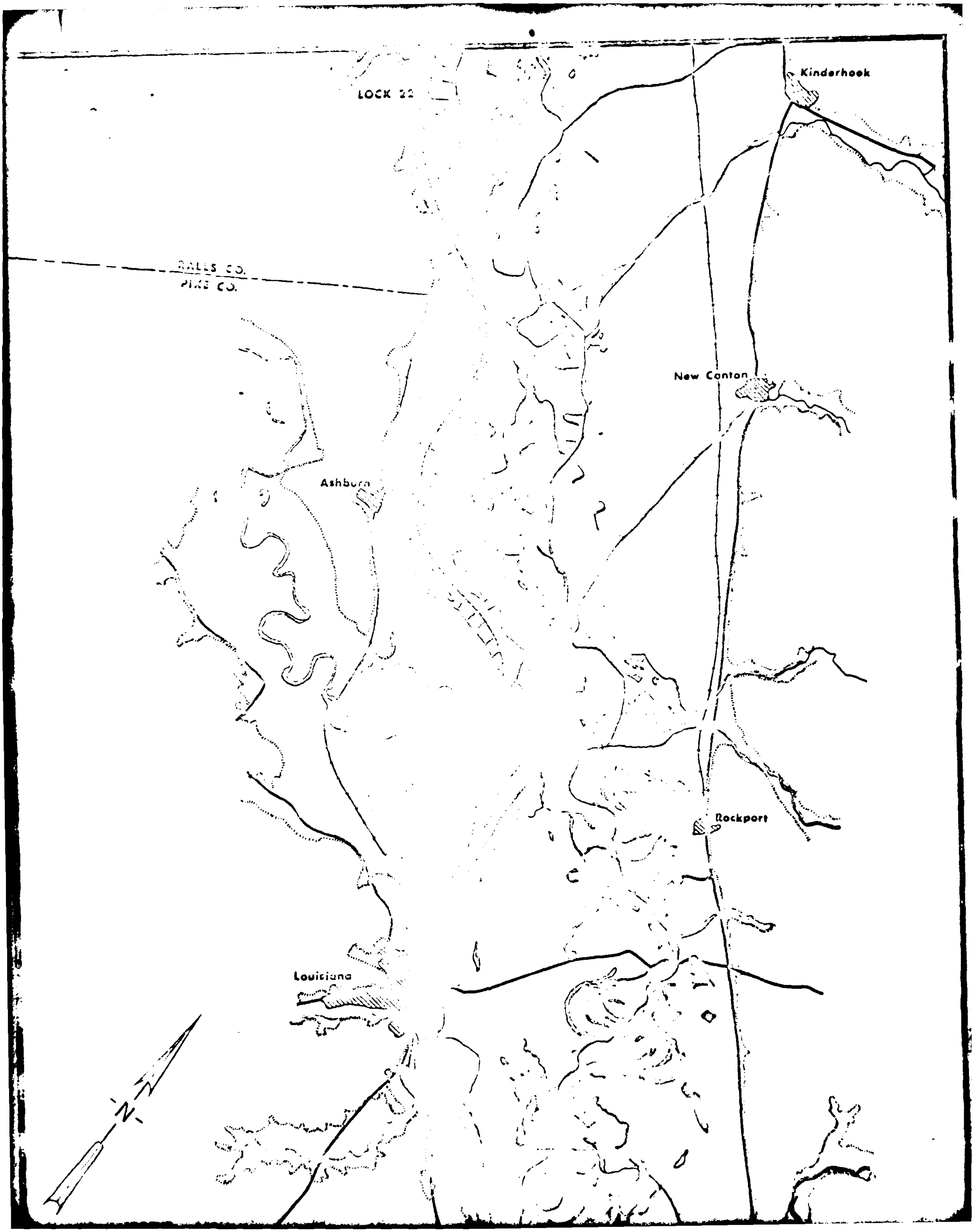
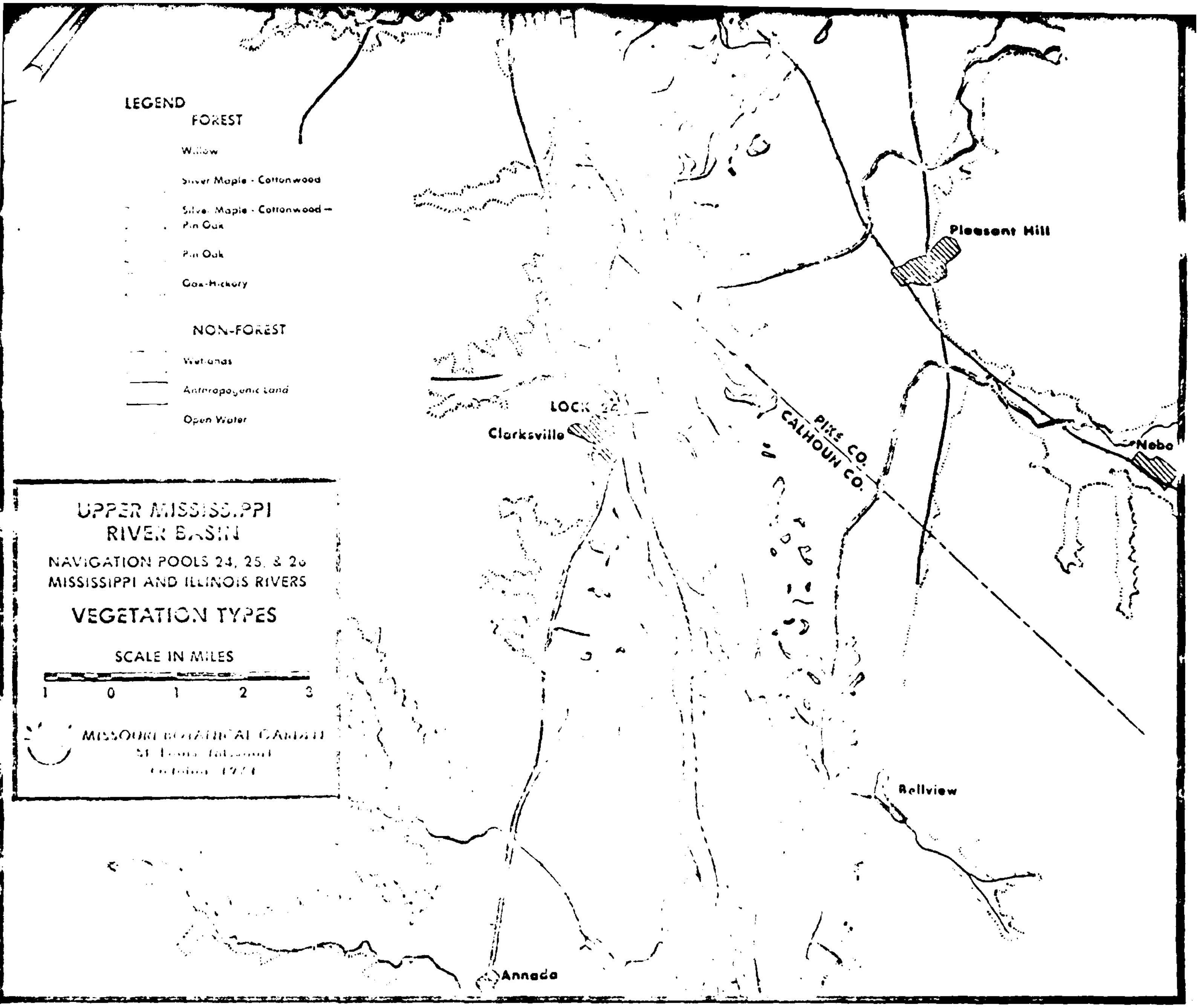

LEGEND
FOREST
Willow
Silver Maple - Cottonwood
Silver Maple - Cottonwood - Pin Oak
Pin Oak
NON-FOREST
Wetlands
Anthropogenic Land
Open Water
NAVIGATION POOLS 24, 25, & 26
MISSISSIPPI AND ILLINOIS RIVERS
VEGETATION TYPES
SCALE IN MILES
1 0 1 2 3
Chautauqua
Elsah
Portage Des Sioux
Principia College
ST. LOUIS CO.
JERSEY CO.
MADISON CO.
West Alton
Alton
GM & O

PLATE 4-A


Pearl
Hillview
Nebo
PIKE CO.
CALHOUN CO.
Belleview
Bluffdale
Kampsville
Eldred
Annada
Illinois
Michael
PIKE CO.
LINCOLN CO.
N
Titus
Spanky

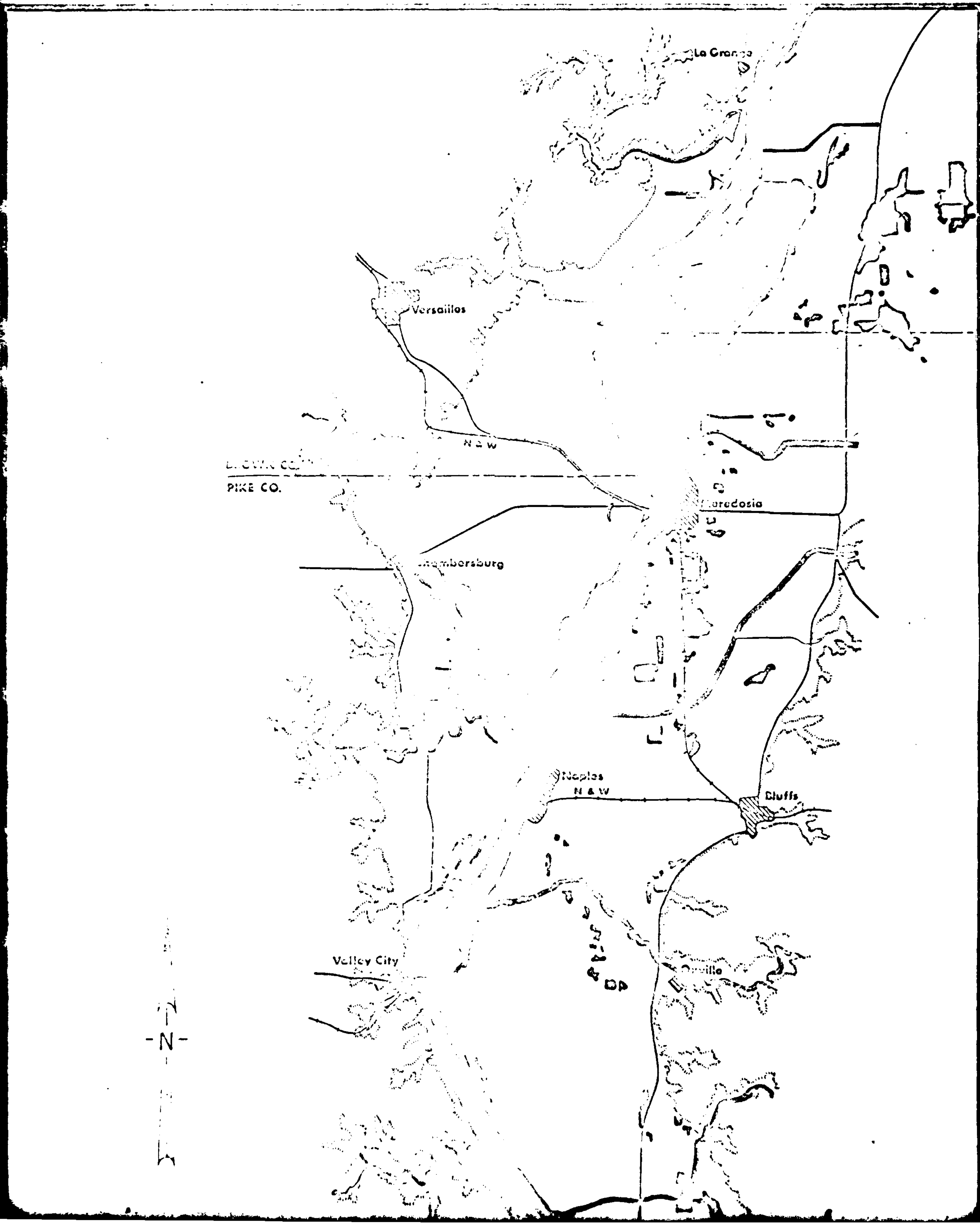

LEGEND
FOREST
Willow
Silver Maple - Cottonwood
NON-FOREST
Open water
UPPER MISSISSIPPI
RIVER BASIN
NAVIGATION POOLS 24, 25, & 26
MISSISSIPPI AND ILLINOIS RIVERS
VEGETATION TYPES
SCALE IN MILES
1 0 1 2 3
Missouri
LOCK 25
Winfield
Hardin
Titus
JERSEY CO.
Nutwood


LOCK 22
Kinderhook
RALLS CO.
PIKE CO.
New Canton
Ashburn
Rockport
Louisiana
N

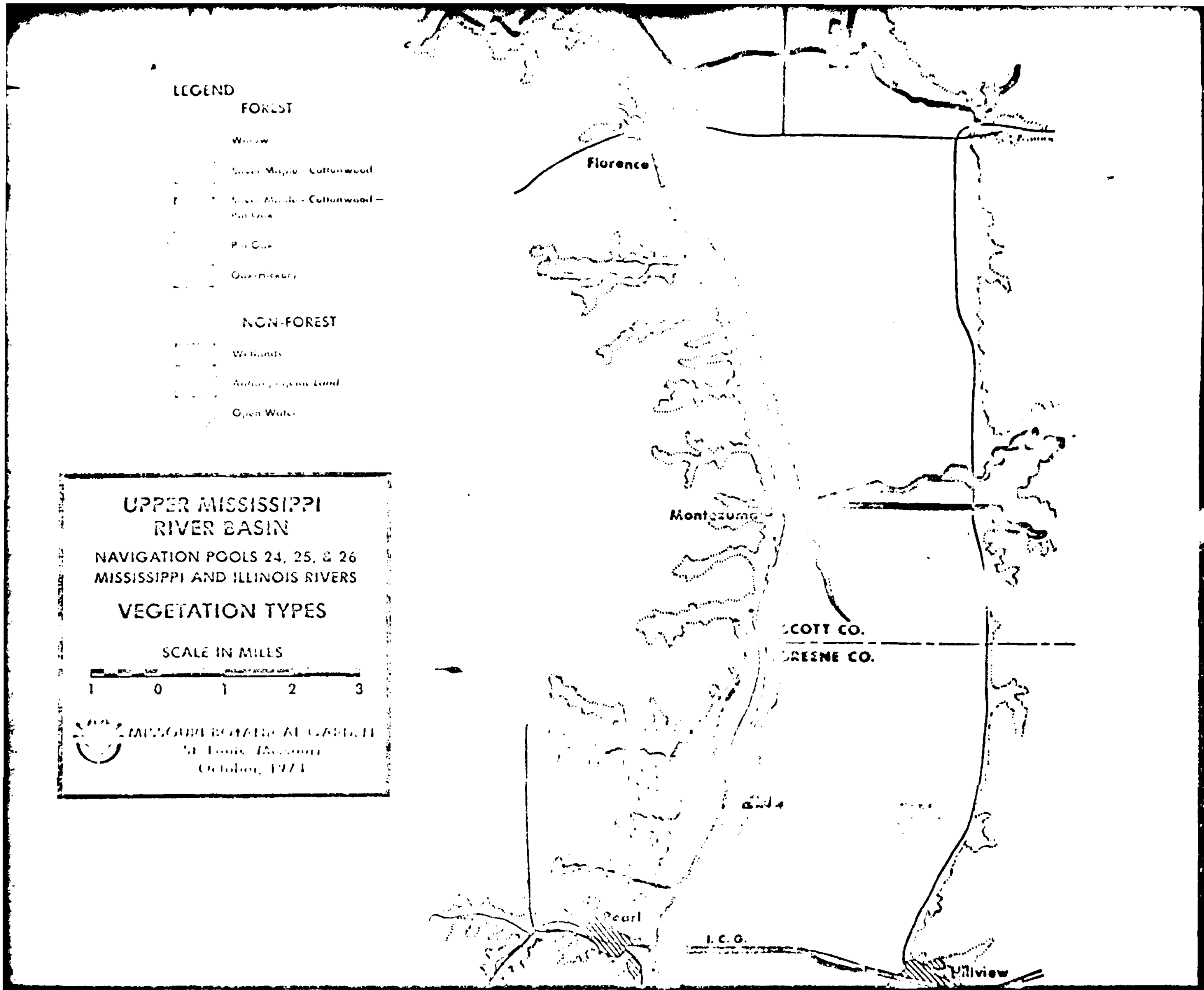


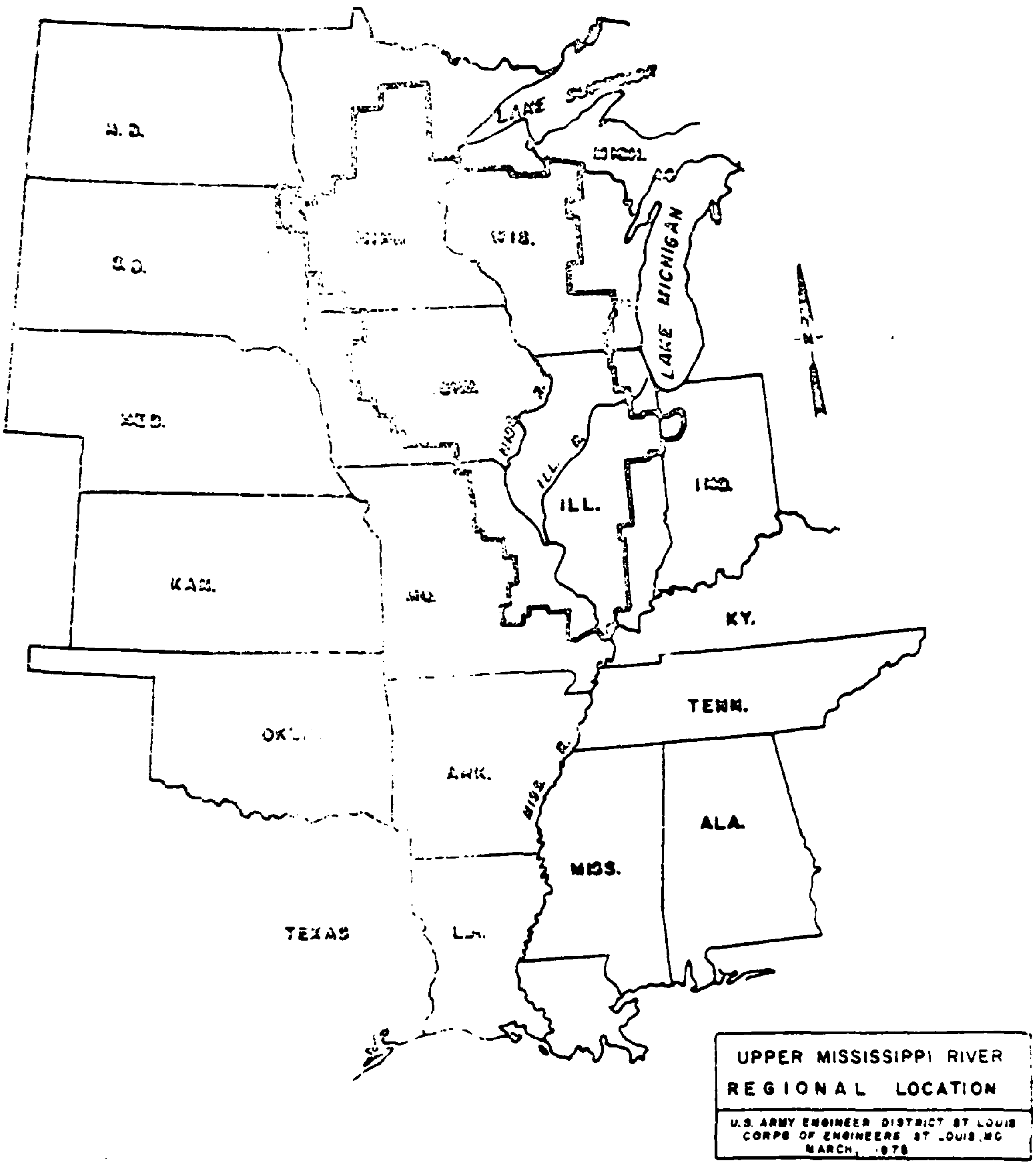
LEGEND
FOREST
Willow
Silver Maple - Cottonwood
Silver Maple - Cottonwood — Pin Oak
Pin Oak
Oak-Hickory
NON-FOREST
Wetlands
Anthropogenic Land
Open Water
UPPER MISSISSIPPI
RIVER BASIN
NAVIGATION POOLS 24, 25, & 26
MISSISSIPPI AND ILLINOIS RIVERS
VEGETATION TYPES
SCALE IN MILES
1 0 1 2 3
MISSOURI BOTANICAL GARDEN
Pleasant Hill
LOCK 24
Clarksville
PIKE CO.
CALHOUN CO.
Nebo
Bellview
Annada

PLATE 4 C

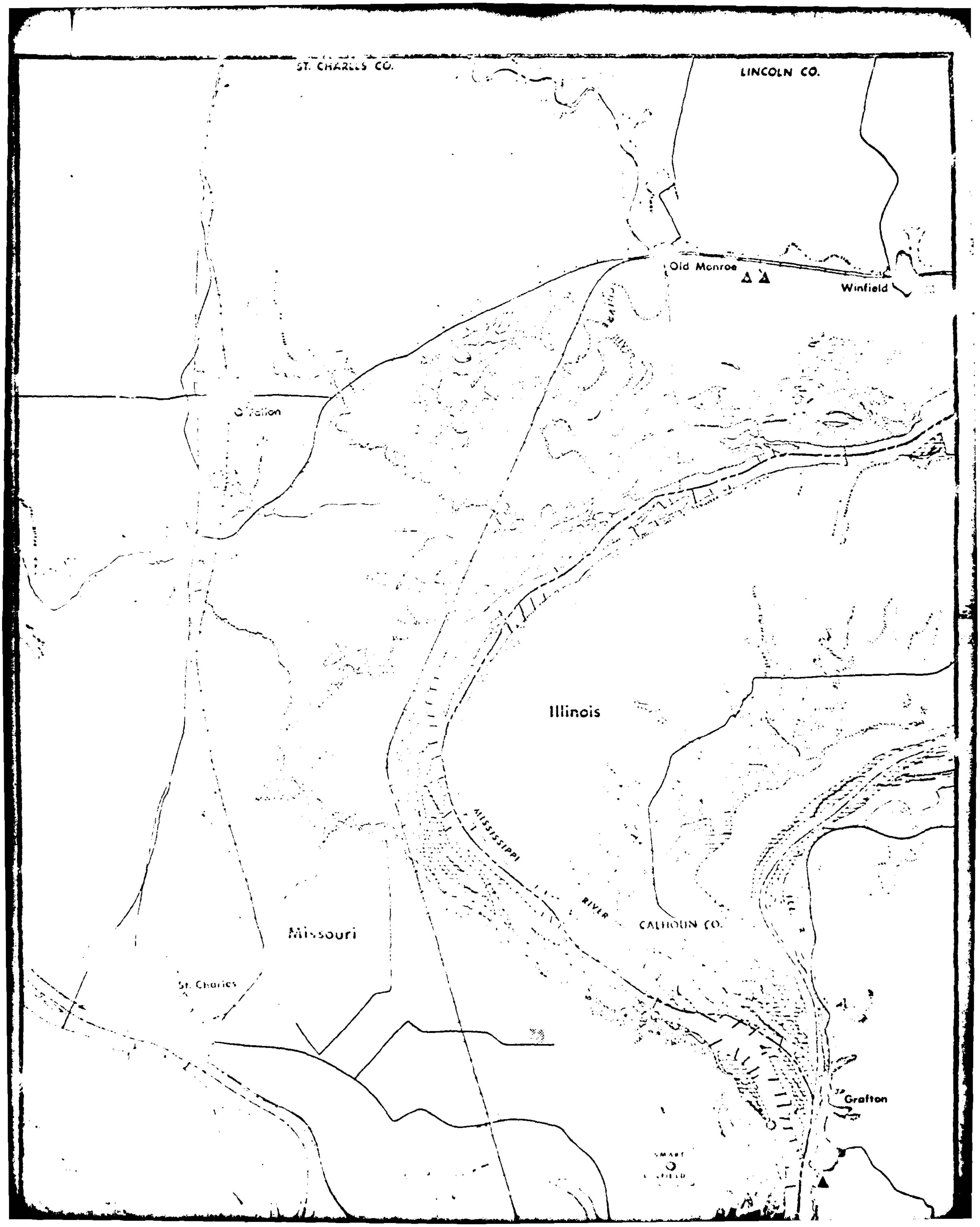


La Grange
Versailles
N & W
BROWN CO.
PIKE CO.
Meredosia
Chambersburg
Naples
N & W
Bluffs
Valley City
Oxville
N


LEGEND
FOREST
NON-FOREST
UPPER MISSISSIPPI
RIVER BASIN
NAVIGATION POOLS 24, 25, & 26
MISSISSIPPI AND ILLINOIS RIVERS
VEGETATION TYPES
SCALE IN MILES
1 0 1 2 3
Florence
Montezuma
Pearl
I. C. G.


LAKE MICHIGAN
WIS.
ILL.
ILL. R.
KY.
TENN.
ARK.
MISS. R.
MISS.
ALA.
TEXAS
N
UPPER MISSISSIPPI RIVER
REGIONAL LOCATION
U.S. ARMY ENGINEER DISTRICT ST LOUIS
CORPS OF ENGINEERS ST LOUIS, MO
MARCH, 1978

LOCATION


ST. CHARLES CO.
LINCOLN CO.
Old Monroe
Winfield
O'Fallon
Illinois
MISSISSIPPI
RIVER
CALHOUN CO.
Missouri
St. Charles
Grafton

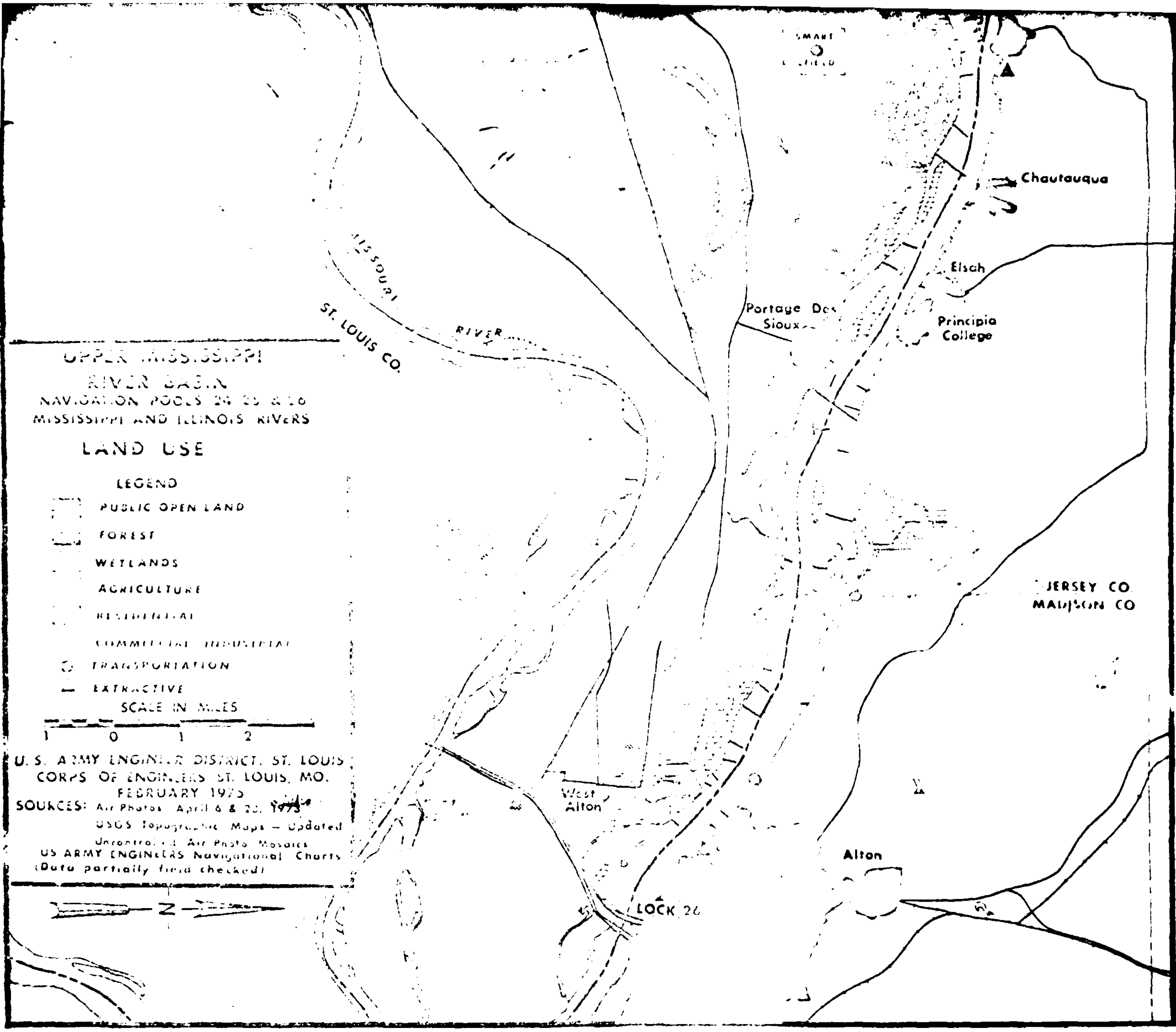
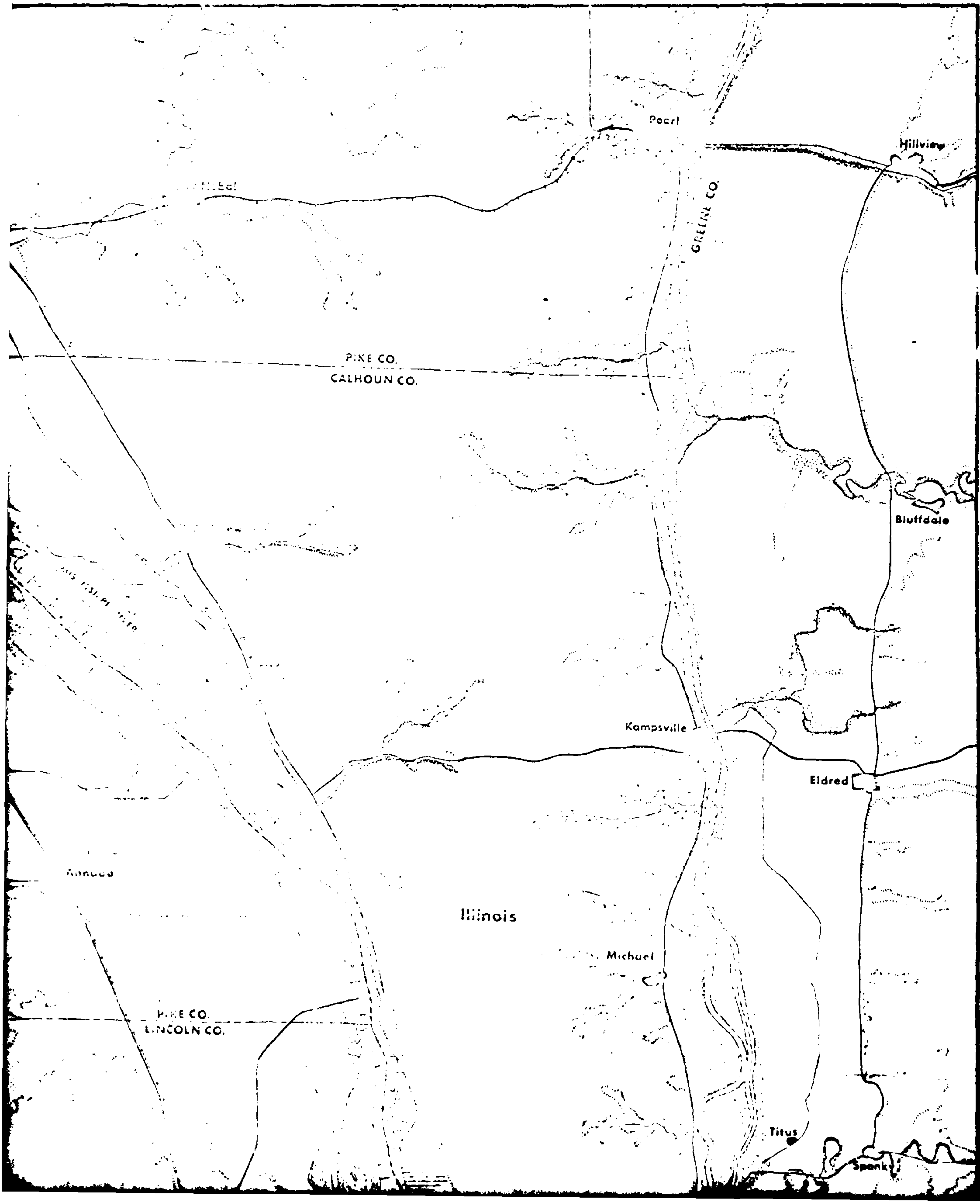

UPPER MISSISSIPPI
RIVER BASIN
NAVIGATION POOLS 24 25 & 26
MISSISSIPPI AND ILLINOIS RIVERS
LAND USE
LEGEND
PUBLIC OPEN LAND
FOREST
WETLANDS
AGRICULTURE
RESIDENTIAL
COMMERCIAL INDUSTRIAL
TRANSPORTATION
EXTRACTIVE
SCALE IN MILES
1 0 1 2
U.S. ARMY ENGINEER DISTRICT, ST. LOUIS
CORPS OF ENGINEERS ST. LOUIS, MO.
FEBRUARY 1975
SOURCES: Air Photos April 6 & 23, 1973
USGS Topographic Maps — Updated
Uncontrolled Air Photo Mosaics
US ARMY ENGINEERS Navigational Charts
(Data partially field checked)
N
MISSOURI RIVER
ST. LOUIS CO.
Chautauqua
Elsah
Portage Des Sioux
Principia College
JERSEY CO.
MADISON CO.
West Alton
Alton
LOCK 26

PLATE 6-A



Pearl
Hillview
GREENE CO.
PIKE CO.
CALHOUN CO.
Bluffdale
Kampsville
Eldred
Illinois
Michael
PIKE CO.
LINCOLN CO.
Titus
Spanky

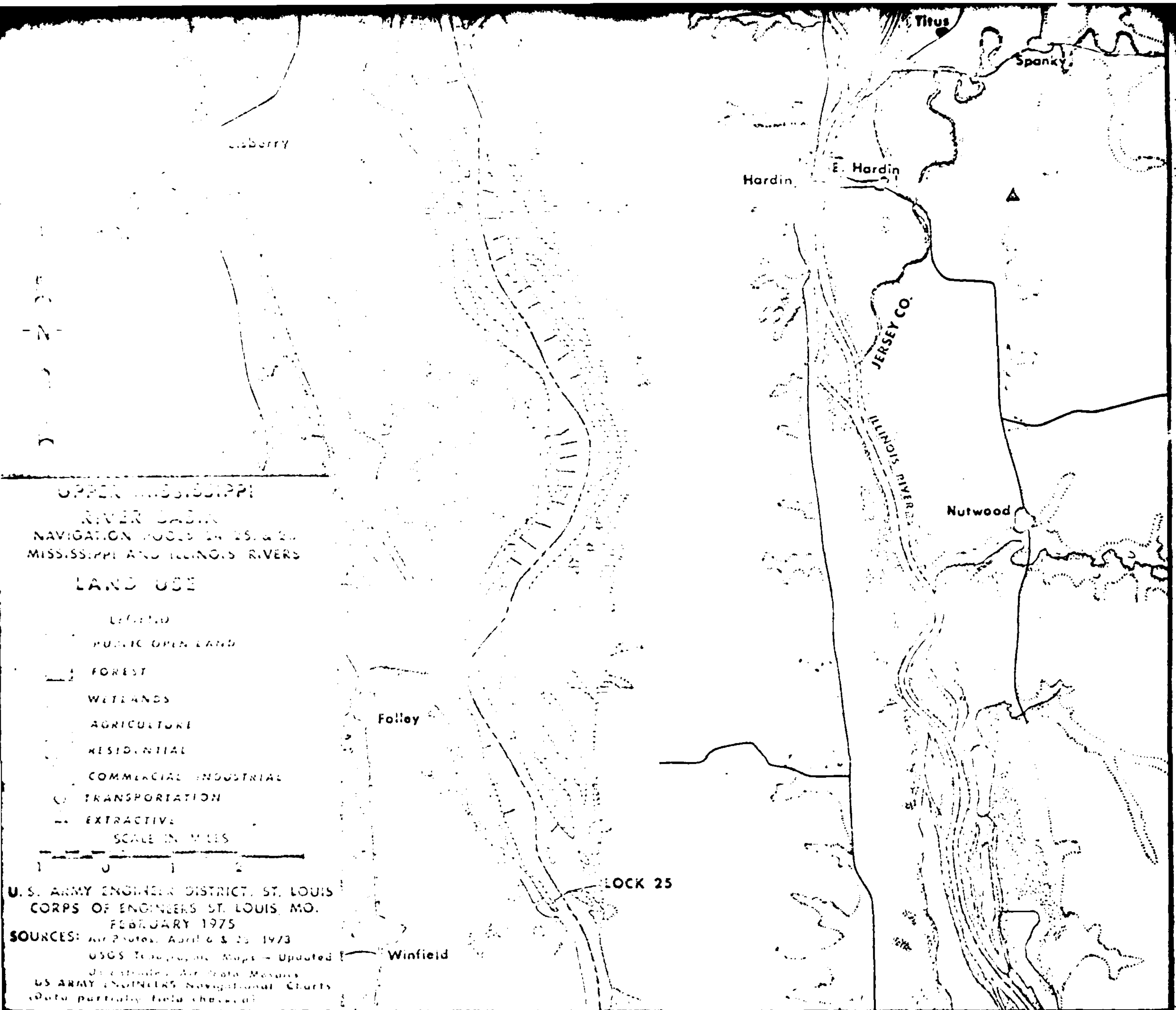
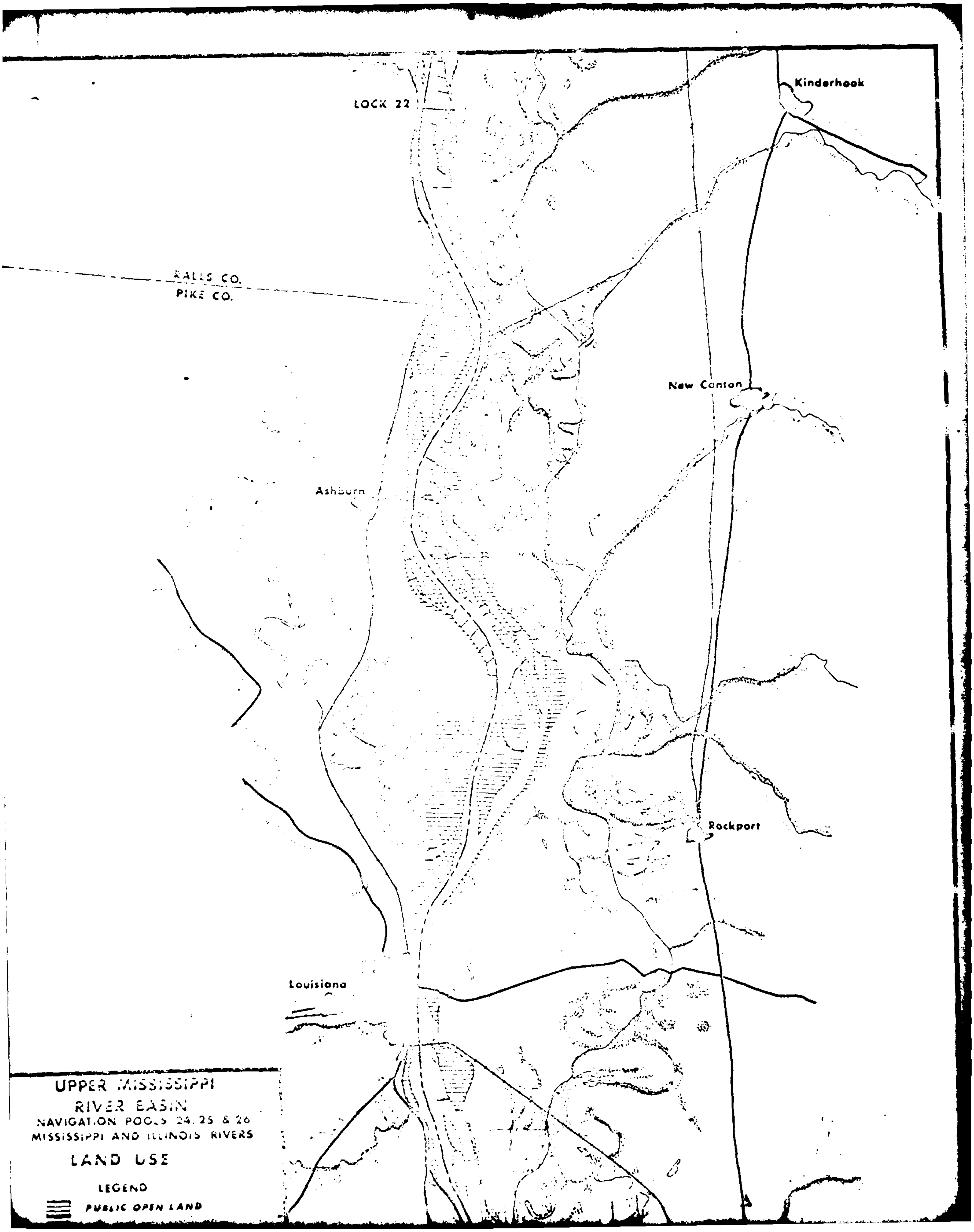
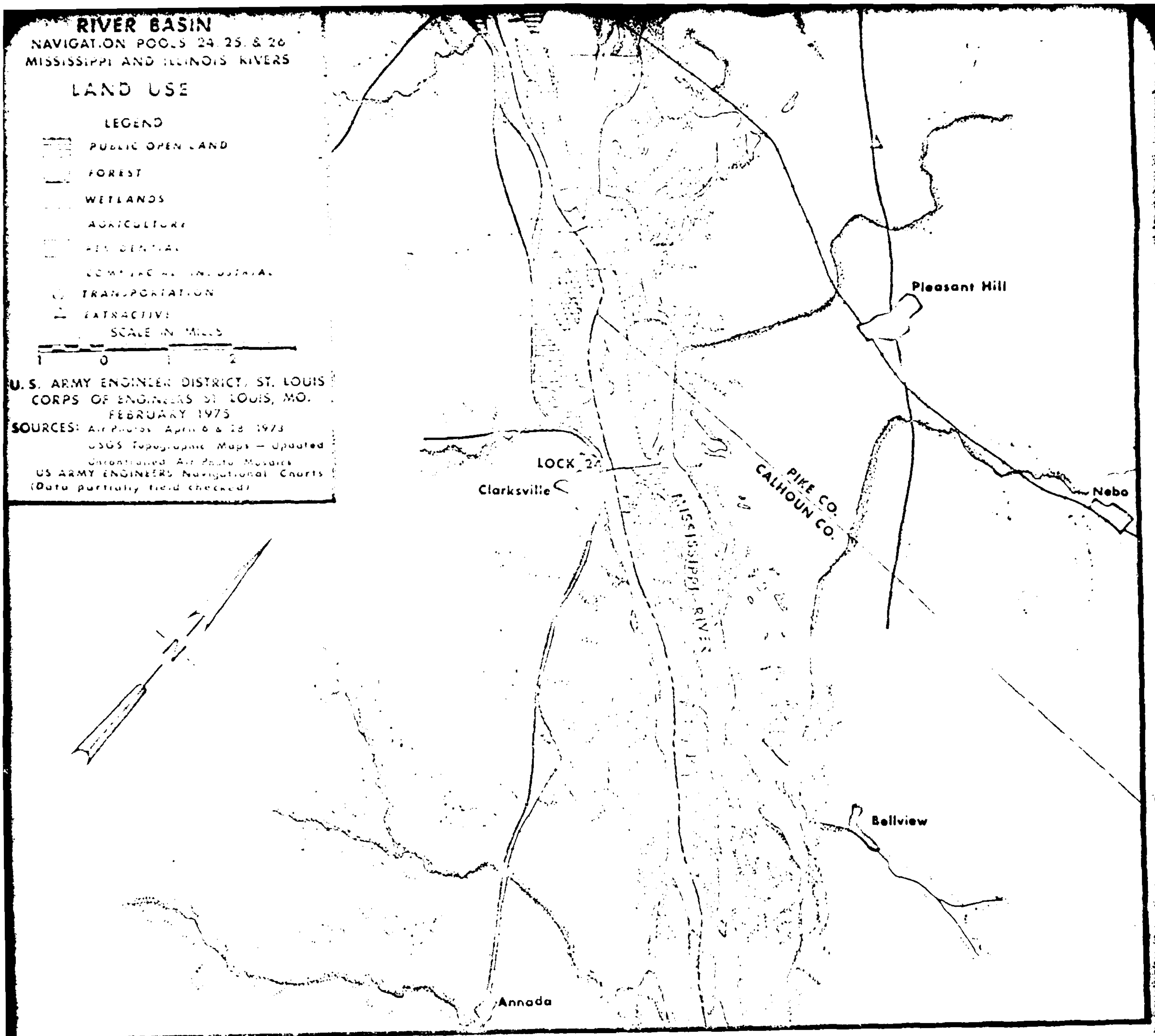

Titus
Spanky
Hardin
E. Hardin
JERSEY CO.
ILLINOIS RIVER
Nutwood
Folley
LOCK 25
Winfield
MISSISSIPPI AND ILLINOIS RIVERS
LAND USE
FOREST
WETLANDS
AGRICULTURE
RESIDENTIAL
COMMERCIAL INDUSTRIAL
TRANSPORTATION
EXTRACTIVE
SCALE IN MILES
1 0 1 2
U.S. ARMY ENGINEER DISTRICT, ST. LOUIS
CORPS OF ENGINEERS ST. LOUIS, MO.
FEBRUARY 1975
SOURCES:

PLATE 6-B

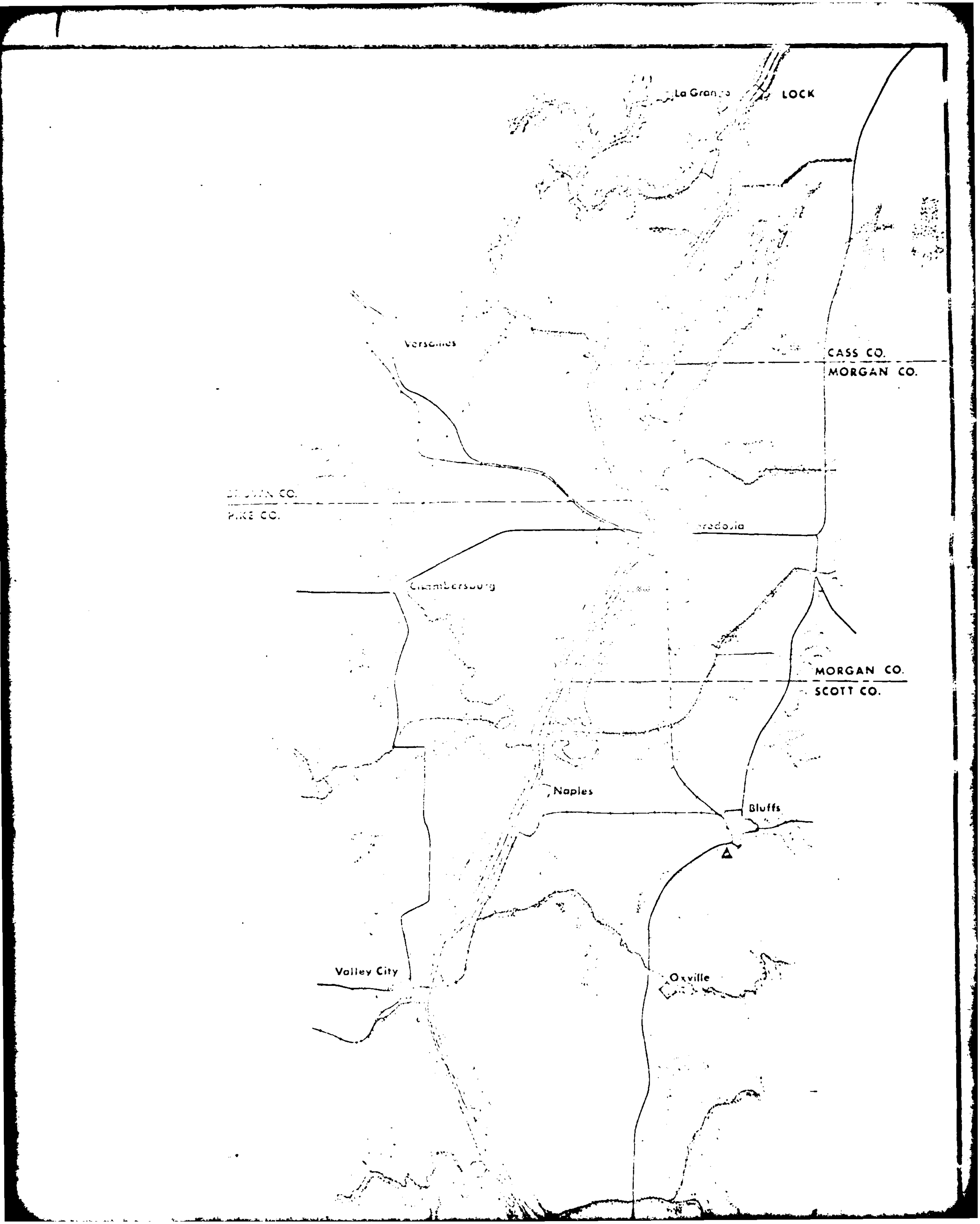


LOCK 22
Kinderhook
RALLS CO.
PIKE CO.
New Canton
Ashburn
Rockport
Louisiana
UPPER MISSISSIPPI
RIVER BASIN
NAVIGATION POOLS 24, 25 & 26
MISSISSIPPI AND ILLINOIS RIVERS
LAND USE
LEGEND
PUBLIC OPEN LAND



RIVER BASIN
NAVIGATION POOLS 24, 25 & 26
MISSISSIPPI AND ILLINOIS RIVERS
LAND USE
LEGEND
PUBLIC OPEN LAND
FOREST
WETLANDS
AGRICULTURE
TRANSPORTATION
EXTRACTIVE
SCALE IN MILES
1 0 1 2
U.S. ARMY ENGINEER DISTRICT, ST. LOUIS
CORPS OF ENGINEERS ST. LOUIS, MO.
SOURCES:
USGS Topographic Maps — Updated
US ARMY ENGINEERS Navigational Charts
(Data partially field checked)
Pleasant Hill
LOCK 24
Clarksville
PIKE CO.
CALHOUN CO.
Nebo
MISSISSIPPI RIVER
Bellview
Annada

PLATE 6-C



La Grange
LOCK
Versailles
CASS CO.
MORGAN CO.
BROWN CO.
PIKE CO.
Meredosia
Chambersburg
MORGAN CO.
SCOTT CO.
Naples
Bluffs
Valley City
Oxville

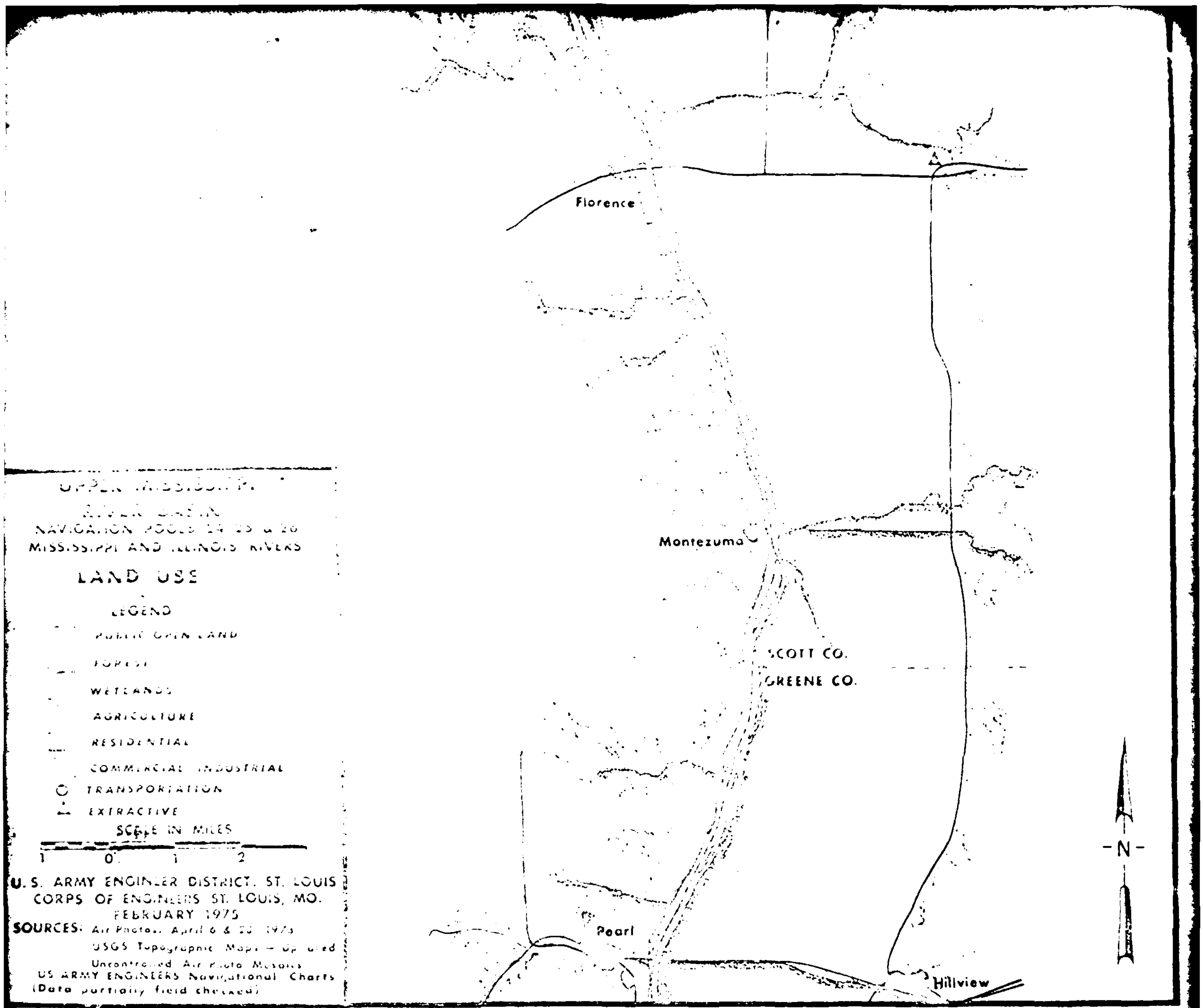

Florence
Montezuma
SCOTT CO.
GREENE CO.
Pearl
Hillview
N
NAVIGATION POOLS 24 25 & 26
MISSISSIPPI AND ILLINOIS RIVERS
LAND USE
LEGEND
PUBLIC OPEN LAND
FOREST
WETLANDS
AGRICULTURE
RESIDENTIAL
COMMERCIAL INDUSTRIAL
TRANSPORTATION
EXTRACTIVE
SCALE IN MILES
1 0 1 2
U.S. ARMY ENGINEER DISTRICT, ST. LOUIS
CORPS OF ENGINEERS ST. LOUIS, MO.
FEBRUARY 1975
SOURCES:
USGS Topographic Maps – Updated
Uncontrolled Air Photo Mosaics
US ARMY ENGINEERS Navigational Charts
(Data partially field checked)

PLATE 6-D

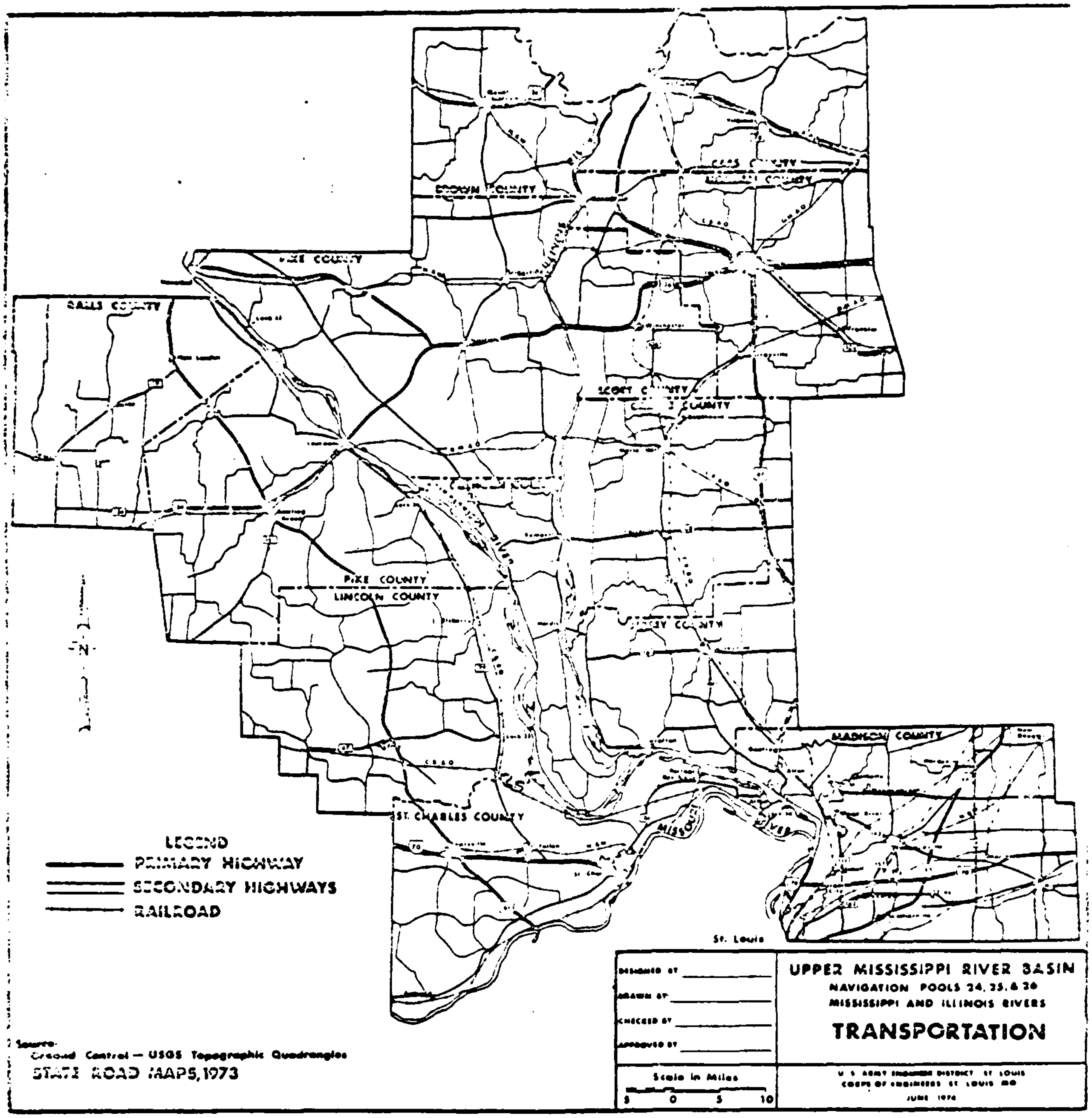
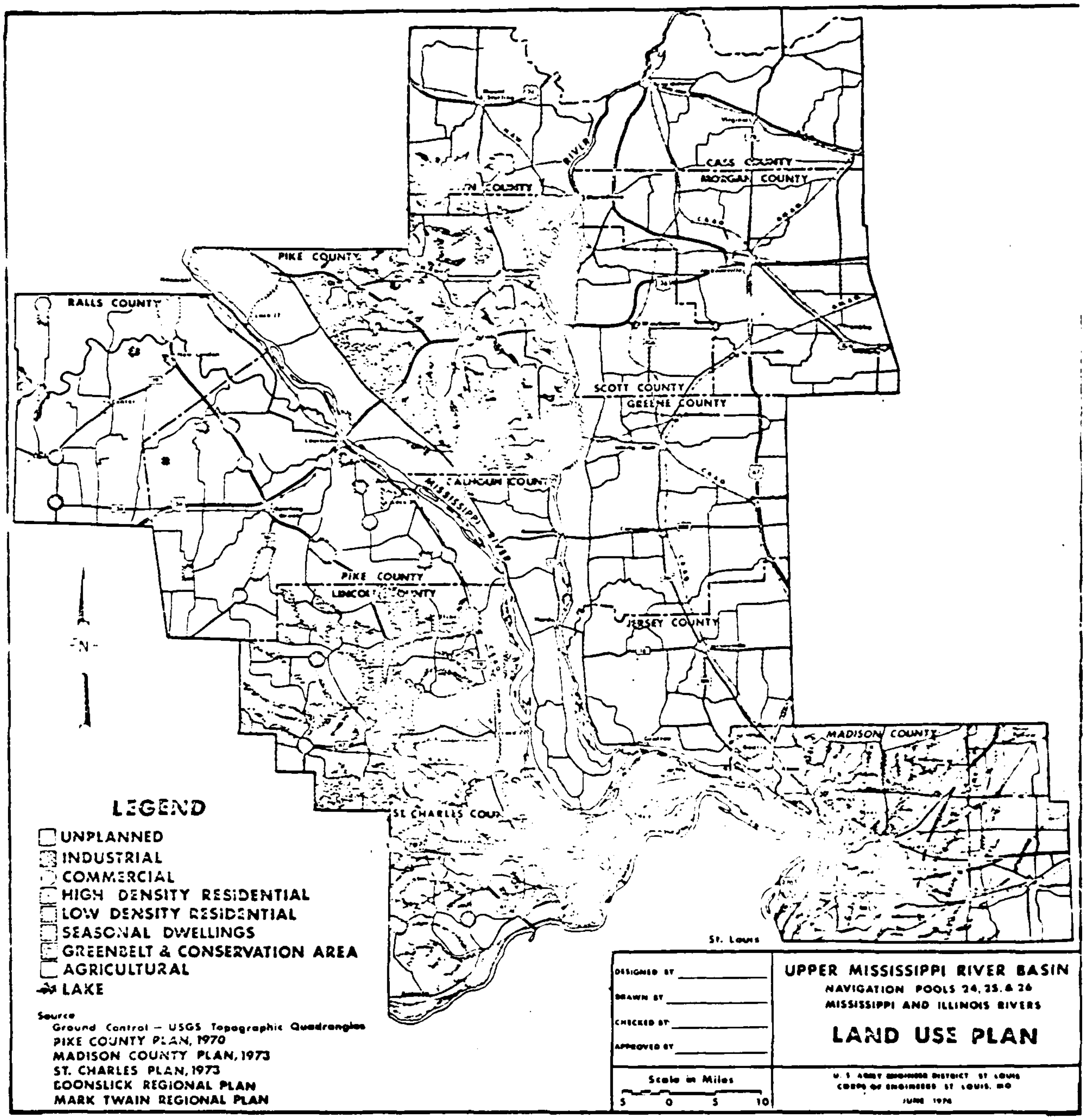
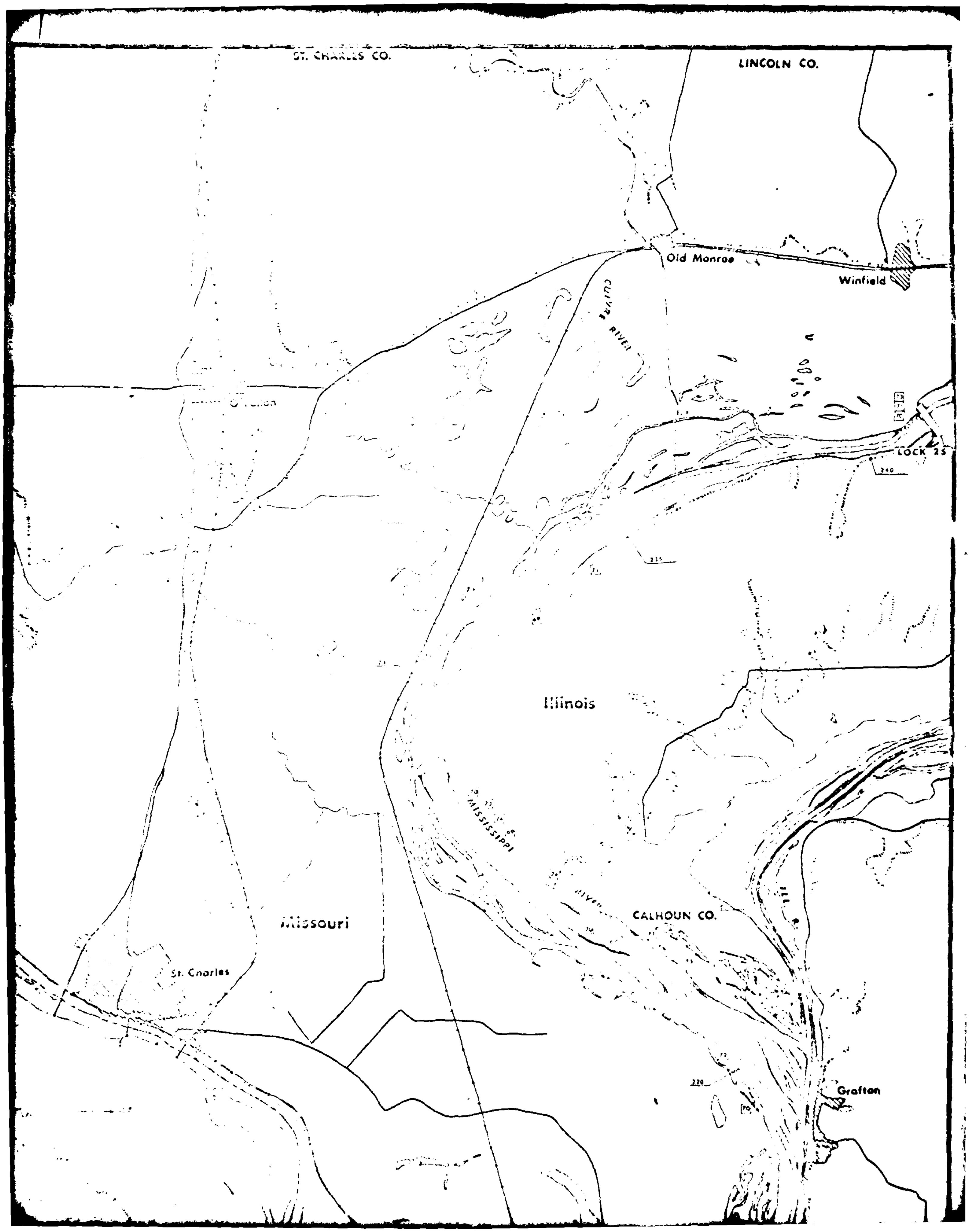

BROWN COUNTY
PIKE COUNTY
RALLS COUNTY
SCOTT COUNTY
PIKE COUNTY
LINCOLN COUNTY
MADISON COUNTY
ST. CHARLES COUNTY
MISSOURI RIVER
St. Louis
N
LEGEND
PRIMARY HIGHWAY
SECONDARY HIGHWAYS
RAILROAD
Source:
Ground Control — USGS Topographic Quadrangles
STATE ROAD MAPS, 1973
DESIGNED BY
DRAWN BY
CHECKED BY
APPROVED BY
Scale in Miles
5 0 5 10
UPPER MISSISSIPPI RIVER BASIN
NAVIGATION POOLS 24, 25, & 26
MISSISSIPPI AND ILLINOIS RIVERS
TRANSPORTATION
U. S. ARMY ENGINEER DISTRICT, ST. LOUIS
CORPS OF ENGINEERS, ST. LOUIS, MO.
JUNE 1974

Plate 7



CASS COUNTY
MORGAN COUNTY
PIKE COUNTY
RALLS COUNTY
SCOTT COUNTY
GREENE COUNTY
CALHOUN COUNTY
MISSISSIPPI RIVER
PIKE COUNTY
LINCOLN COUNTY
JERSEY COUNTY
MADISON COUNTY
ST CHARLES COUNTY
St. Louis
N
LEGEND
UNPLANNED
INDUSTRIAL
COMMERCIAL
HIGH DENSITY RESIDENTIAL
LOW DENSITY RESIDENTIAL
SEASONAL DWELLINGS
GREENBELT & CONSERVATION AREA
AGRICULTURAL
LAKE
Source
Ground Control – USGS Topographic Quadrangles
PIKE COUNTY PLAN, 1970
MADISON COUNTY PLAN, 1973
ST. CHARLES PLAN, 1973
BOONSLICK REGIONAL PLAN
MARK TWAIN REGIONAL PLAN
DESIGNED BY
DRAWN BY
CHECKED BY
APPROVED BY
Scale in Miles
5 0 5 10
UPPER MISSISSIPPI RIVER BASIN
NAVIGATION POOLS 24, 25, & 26
MISSISSIPPI AND ILLINOIS RIVERS
LAND USE PLAN
CORPS OF ENGINEERS ST. LOUIS, MO

Plate 8



ST. CHARLES CO.
LINCOLN CO.
Old Monroe
Winfield
CUIVRE RIVER
LOCK 25
240
235
Illinois
MISSISSIPPI
RIVER
CALHOUN CO.
Missouri
St. Charles
220
Grafton

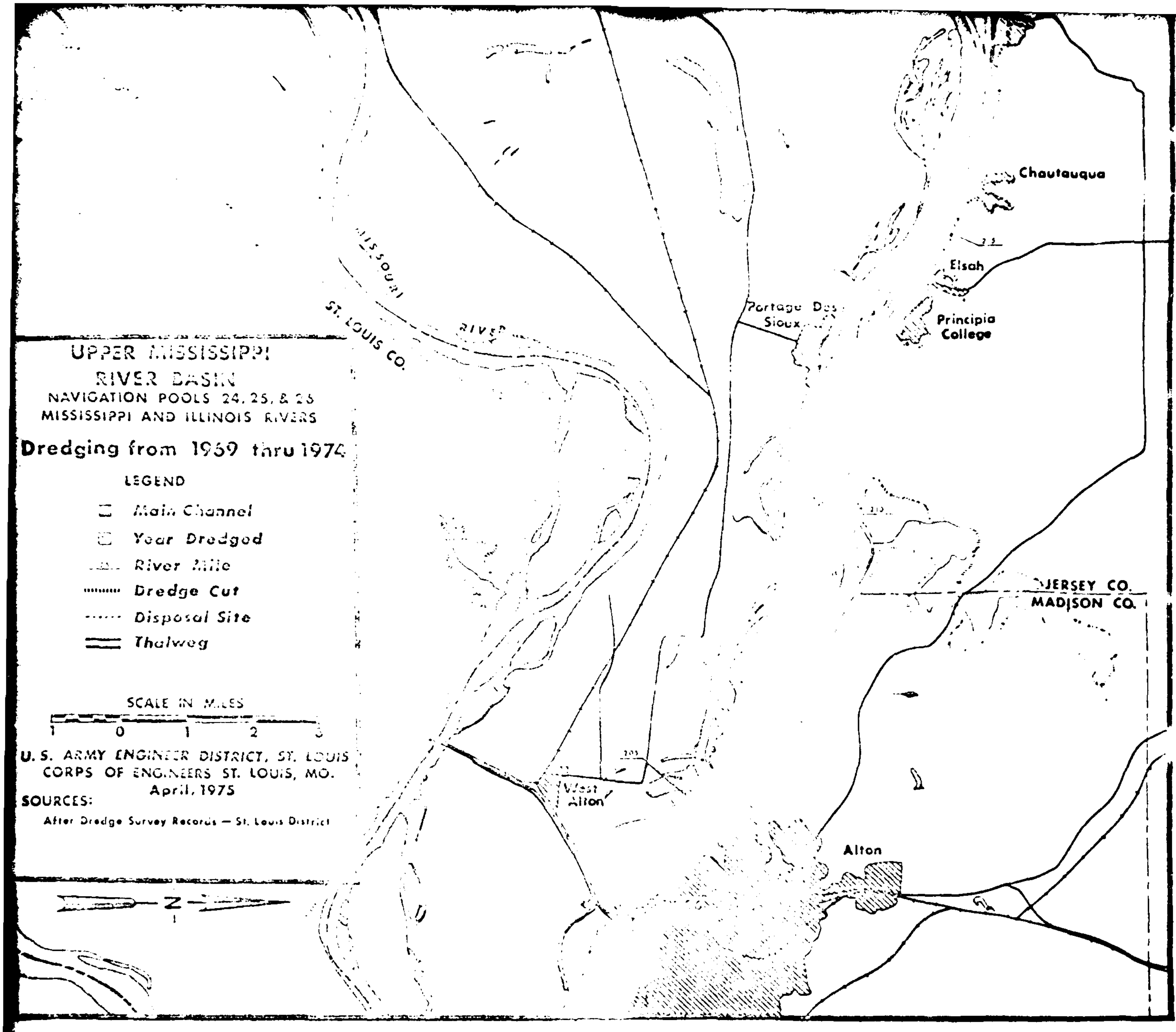
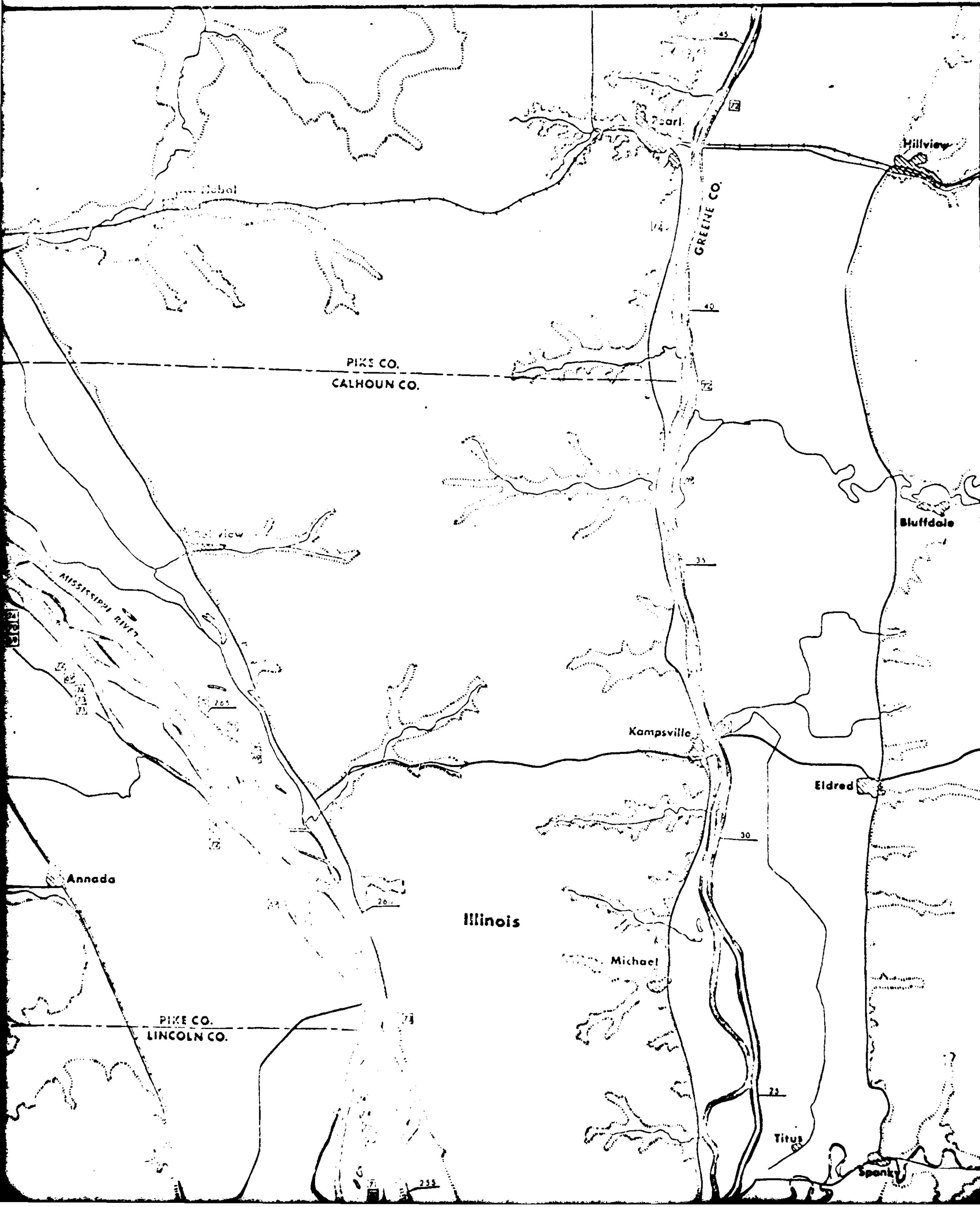
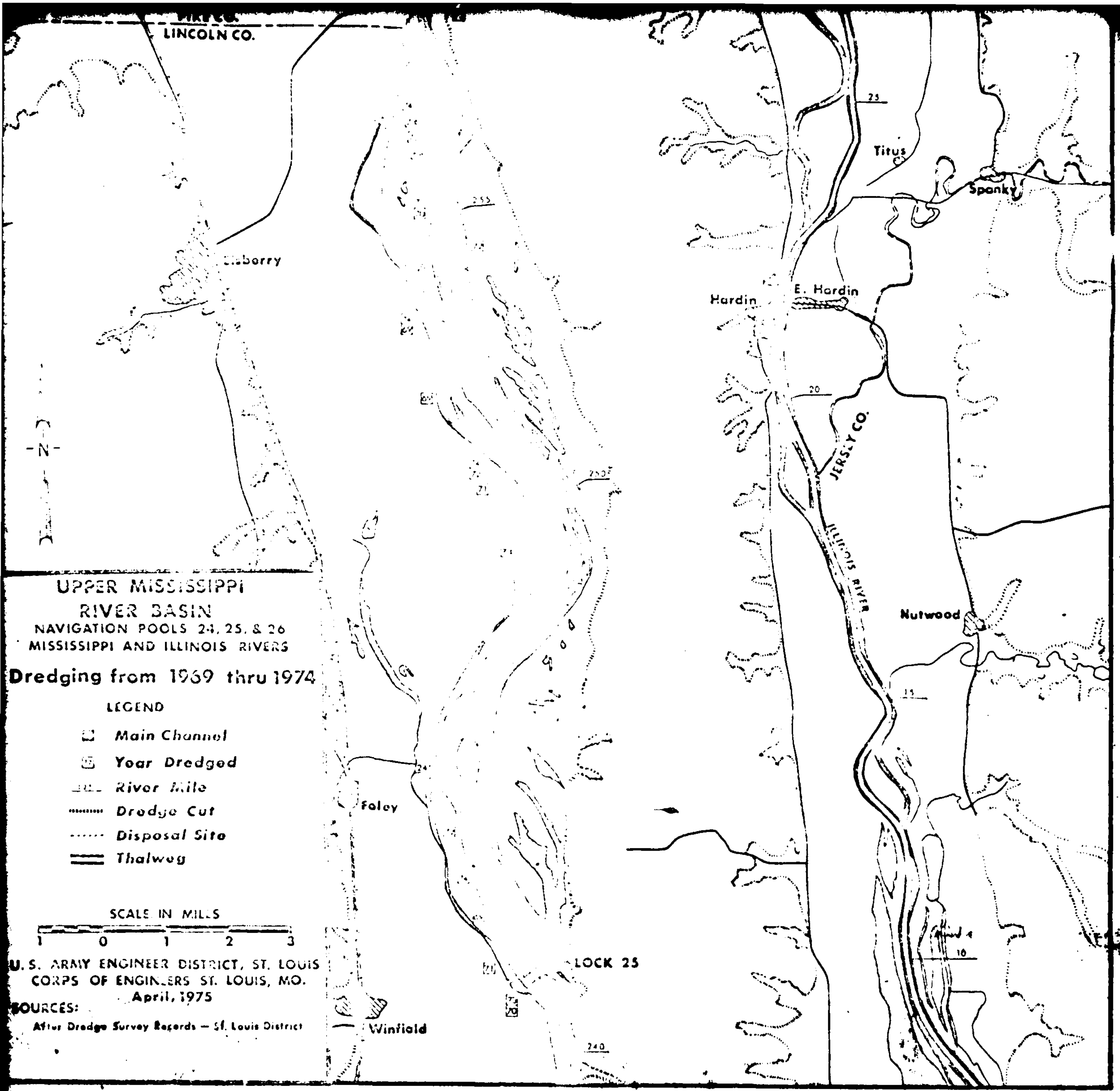

UPPER MISSISSIPPI
RIVER BASIN
NAVIGATION POOLS 24, 25, & 26
MISSISSIPPI AND ILLINOIS RIVERS
Dredging from 1969 thru 1974
LEGEND
Main Channel
Year Dredged
River Mile
Dredge Cut
Disposal Site
Thalweg
SCALE IN MILES
1 0 1 2 3
U. S. ARMY ENGINEER DISTRICT, ST. LOUIS
CORPS OF ENGINEERS ST. LOUIS, MO.
April, 1975
SOURCES:
After Dredge Survey Records — St. Louis District
MISSOURI
RIVER
ST. LOUIS CO.
Chautauqua
Elsah
Portage Des Sioux
Principia College
JERSEY CO.
MADISON CO.
West Alton
Alton

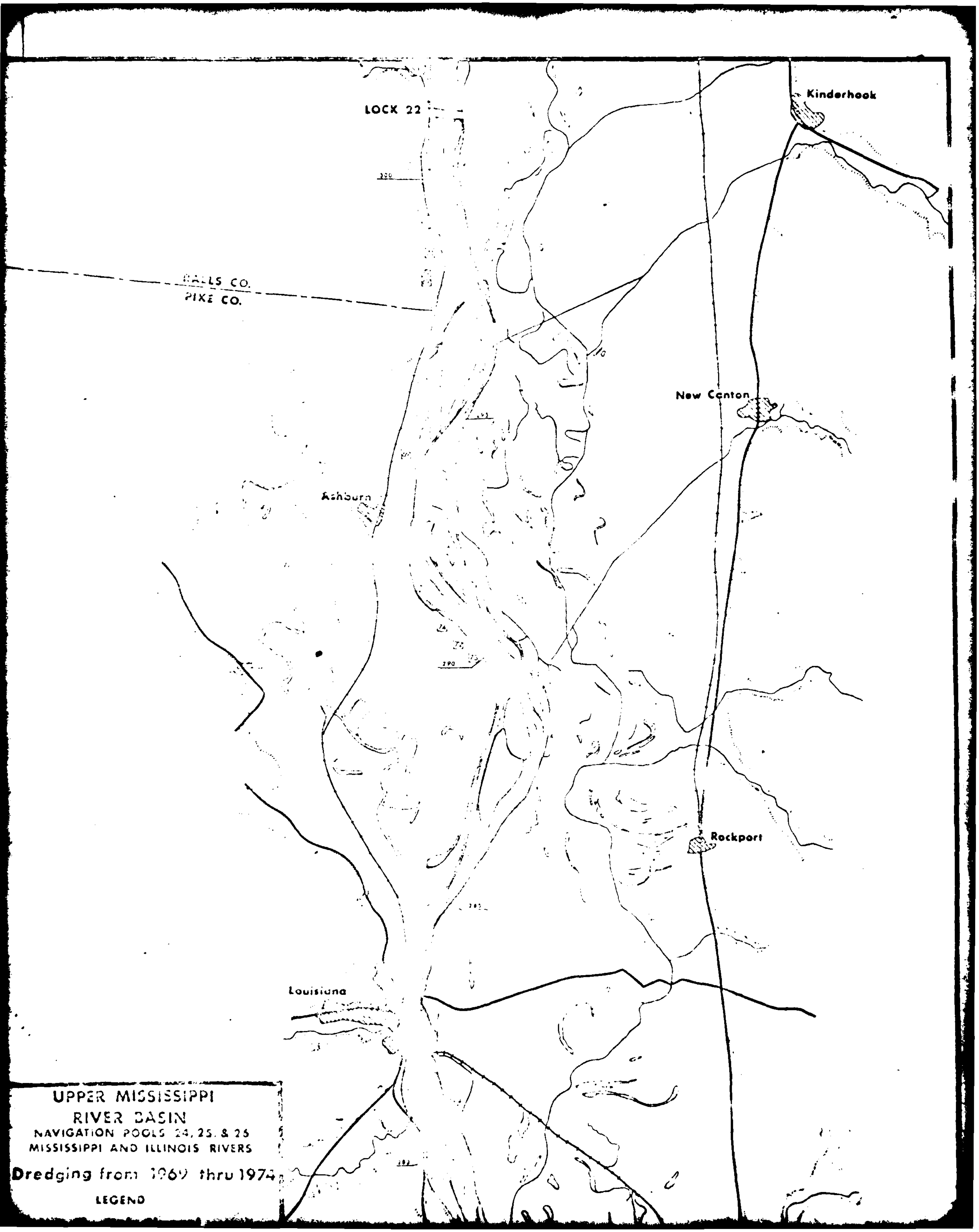
PLATE 9-A

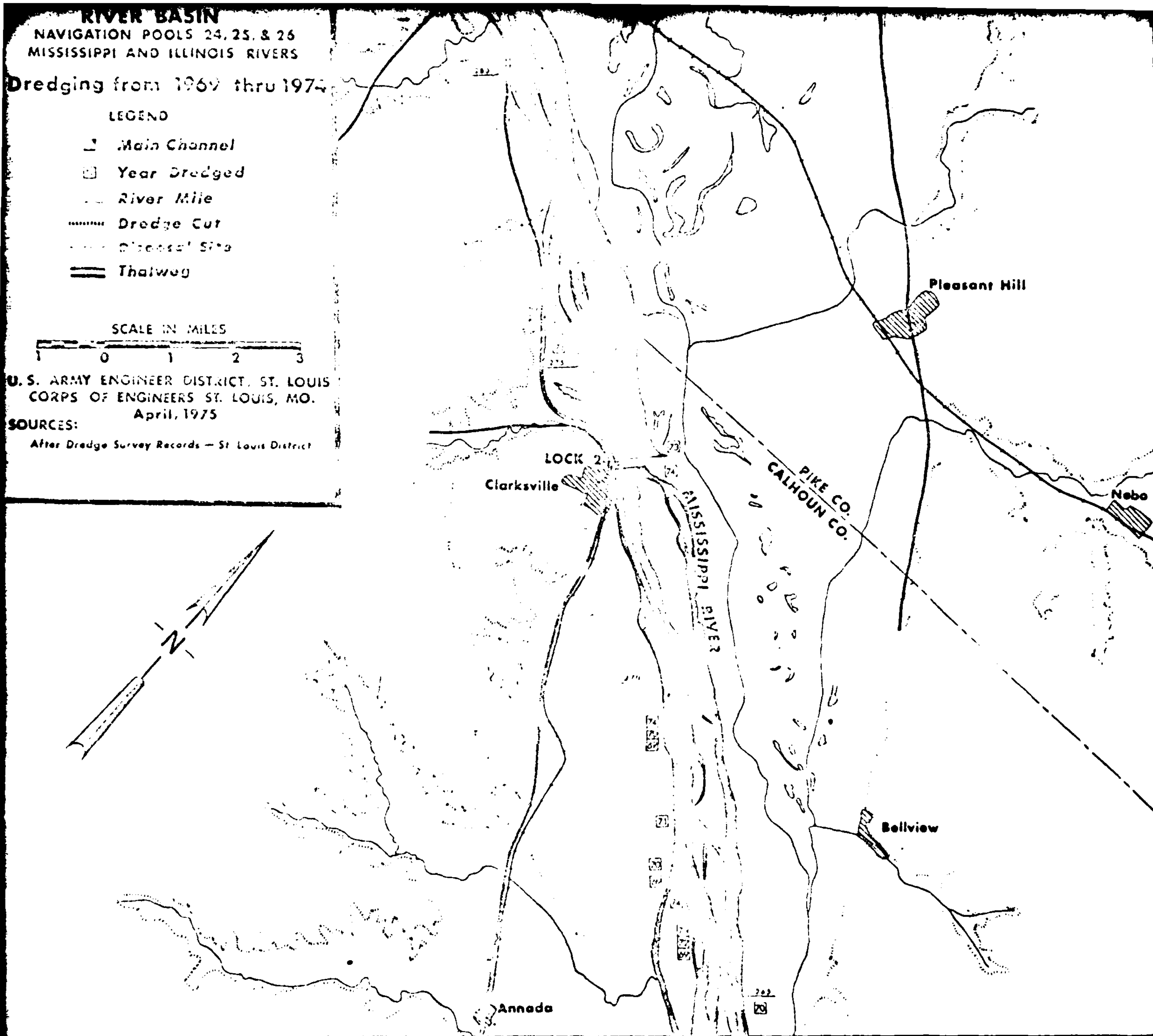

Pearl
Hillview
GREENE CO.
PIKE CO.
CALHOUN CO.
MISSISSIPPI RIVER
Bluffdale
Kampsville
Eldred
Annada
Illinois
Michael
PIKE CO.
LINCOLN CO.
Titus
Spanky
45
40
35
30
25
26
255
265



LINCOLN CO.
Elsberry
Hardin
E. Hardin
Titus
Spanky
JERSEY CO.
ILLINOIS RIVER
Nutwood
Foley
LOCK 25
Winfield
N
UPPER MISSISSIPPI
RIVER BASIN
NAVIGATION POOLS 24, 25, & 26
MISSISSIPPI AND ILLINOIS RIVERS
Dredging from 1969 thru 1974
LEGEND
Main Channel
Year Dredged
River Mile
Dredge Cut
Disposal Site
Thalweg
SCALE IN MILES
1 0 1 2 3
U.S. ARMY ENGINEER DISTRICT, ST. LOUIS
CORPS OF ENGINEERS ST. LOUIS, MO.
April, 1975
SOURCES:
After Dredge Survey Records — St. Louis District

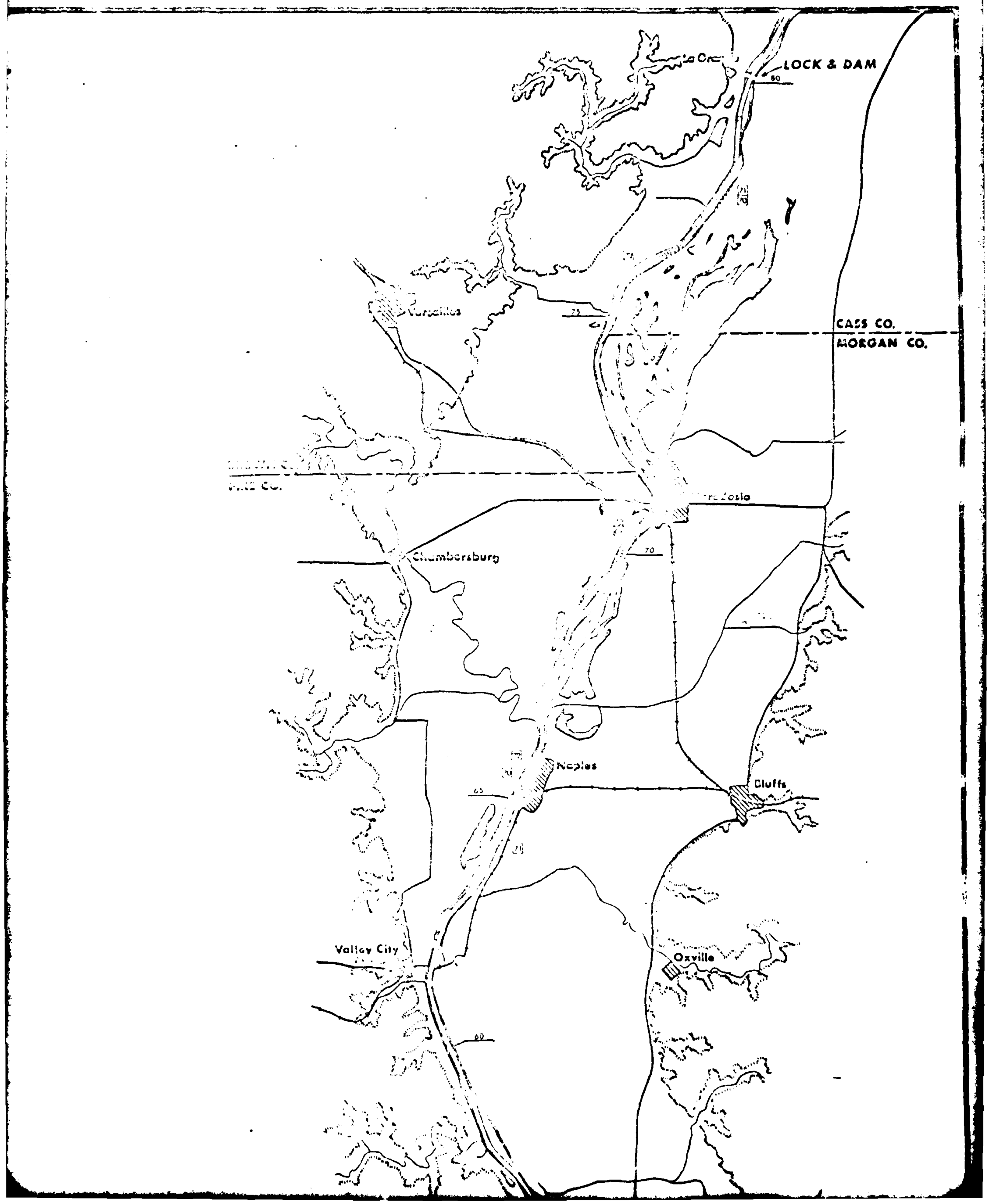
PLATE 9-B


LOCK 22
Kinderhook
RALLS CO.
PIKE CO.
New Canton
Ashburn
Rockport
Louisiana
UPPER MISSISSIPPI
RIVER BASIN
NAVIGATION POOLS 24, 25, & 26
MISSISSIPPI AND ILLINOIS RIVERS
Dredging from 1969 thru 1974
LEGEND

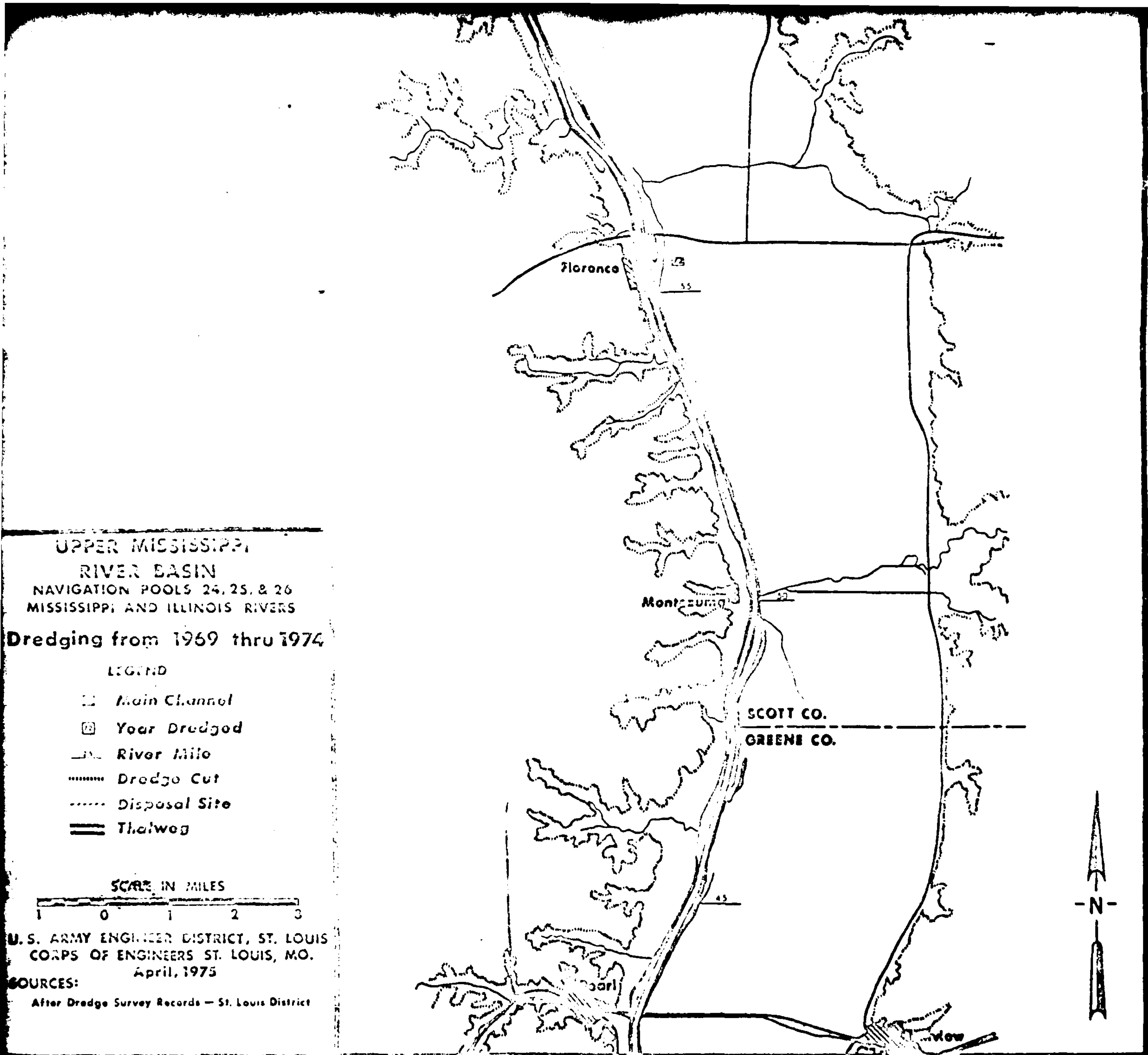


RIVER BASIN
NAVIGATION POOLS 24, 25, & 26
MISSISSIPPI AND ILLINOIS RIVERS
Dredging from 1969 thru 1974
LEGEND
Main Channel
Year Dredged
River Mile
Dredge Cut
Thalweg
SCALE IN MILES
1 0 1 2 3
U. S. ARMY ENGINEER DISTRICT, ST. LOUIS
CORPS OF ENGINEERS ST. LOUIS, MO.
April, 1975
SOURCES:
After Dredge Survey Records — St. Louis District
N
LOCK 24
Clarksville
MISSISSIPPI RIVER
PIKE CO.
CALHOUN CO.
Pleasant Hill
Nebo
Bellview
Annada

PLATE 9-C



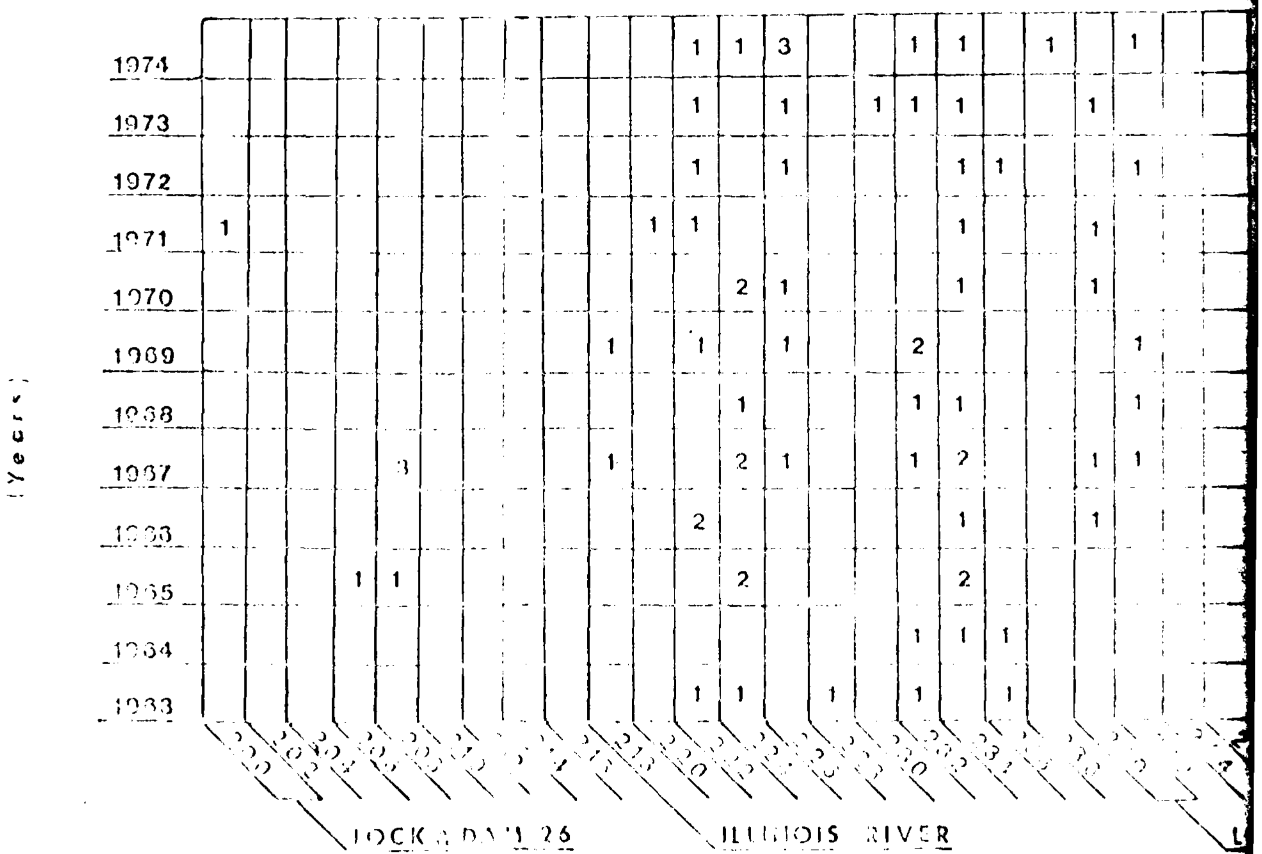
LOCK & DAM
80
75
CASS CO.
MORGAN CO.
Versailles
Chambersburg
70
Naples
65
Bluffs
Valley City
Oxville
60



UPPER MISSISSIPPI
RIVER BASIN
NAVIGATION POOLS 24, 25, & 26
MISSISSIPPI AND ILLINOIS RIVERS
Dredging from 1969 thru 1974
LEGEND
Main Channel
Year Dredged
River Mile
Dredge Cut
Disposal Site
Thalweg
SCALE IN MILES
1 0 1 2 3
U.S. ARMY ENGINEER DISTRICT, ST. LOUIS
CORPS OF ENGINEERS ST. LOUIS, MO.
April, 1975
SOURCES:
After Dredge Survey Records — St. Louis District
Florence
55
Montezuma
50
SCOTT CO.
GREENE CO.
45
N

PLATE 9-D

DREDGING LOC
MISSISSIPPI



River Miles

2 Number of Times

GING LOCATION MATRIX
SSISSIPPI RIVER

																															TOTAL 100 c.y.
	1		1				1	1	1	1			1		3	2		1									1				16439
		1				2				1	1		1		2			1									1				9974
1			1				1		1	1			1		1							1					1				18374
		1					1		1					1	1				1												17097
		1							1			1	1	3	1	1															13396
			1					2	1			1		1	2	1													1		15984
			1							1			2	2	1	1		1					1								18322
		1	1										2	3		1	1														1342
		1					1		2					2																	1610
							1			1				2	2	1										1			1		1390
1															1			1										1			838
1							1								1	1															1081
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	250	252	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	282	[illegible]	[illegible]	288	[illegible]	292	[illegible]	300	

LOCK & DAM 25

LOCK & DAM 24

SALT RIVER

iver Miles

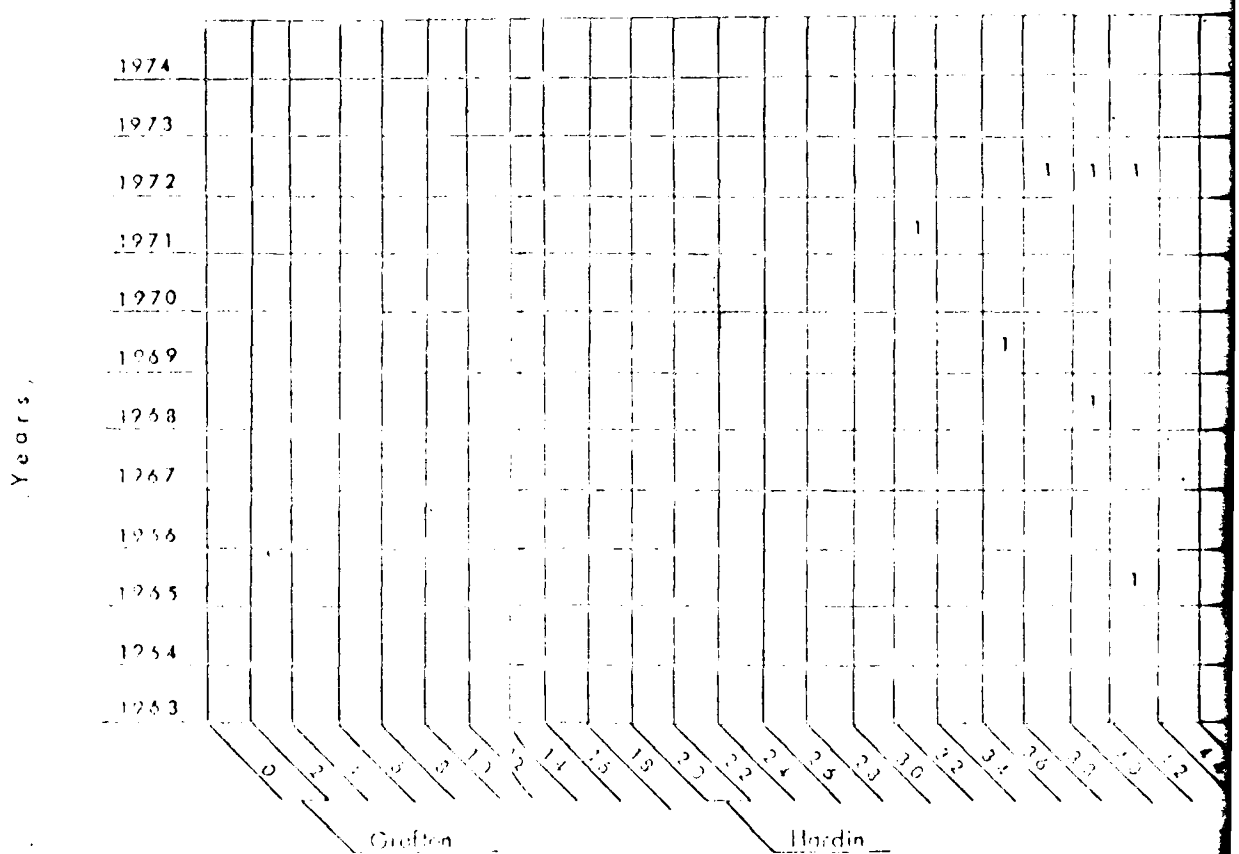
		TOTAL (100 c.y.)
		16439
		9974
		18374
		17097
		13398
1		15984
		18322
		18428
		16103
1		13902
		8386
		10818

292 300

T RIVER

Plate 10

DREDGING LO
ILLINO



(River Miles)

[2] Number of times dredged

...GING LOCATION MATRIX
ILLINOIS RIVER

																						TOTALS [100 c.y.]
																						0
																						0
	1	1	1						1					1			1			1		14536
														1							1	7799
														1							1	13396
1															1		1					16322
		1																			1	2027
							1							1					1			5733
														1	1					1		2780
			1						1												1	5632
																						0
																					1	737

36 38 40 42 44 46 48 50 52 54 56 58 60 62 64 66 68 70 72 74 76 78 80

Naples

La Grange Lock & Dam

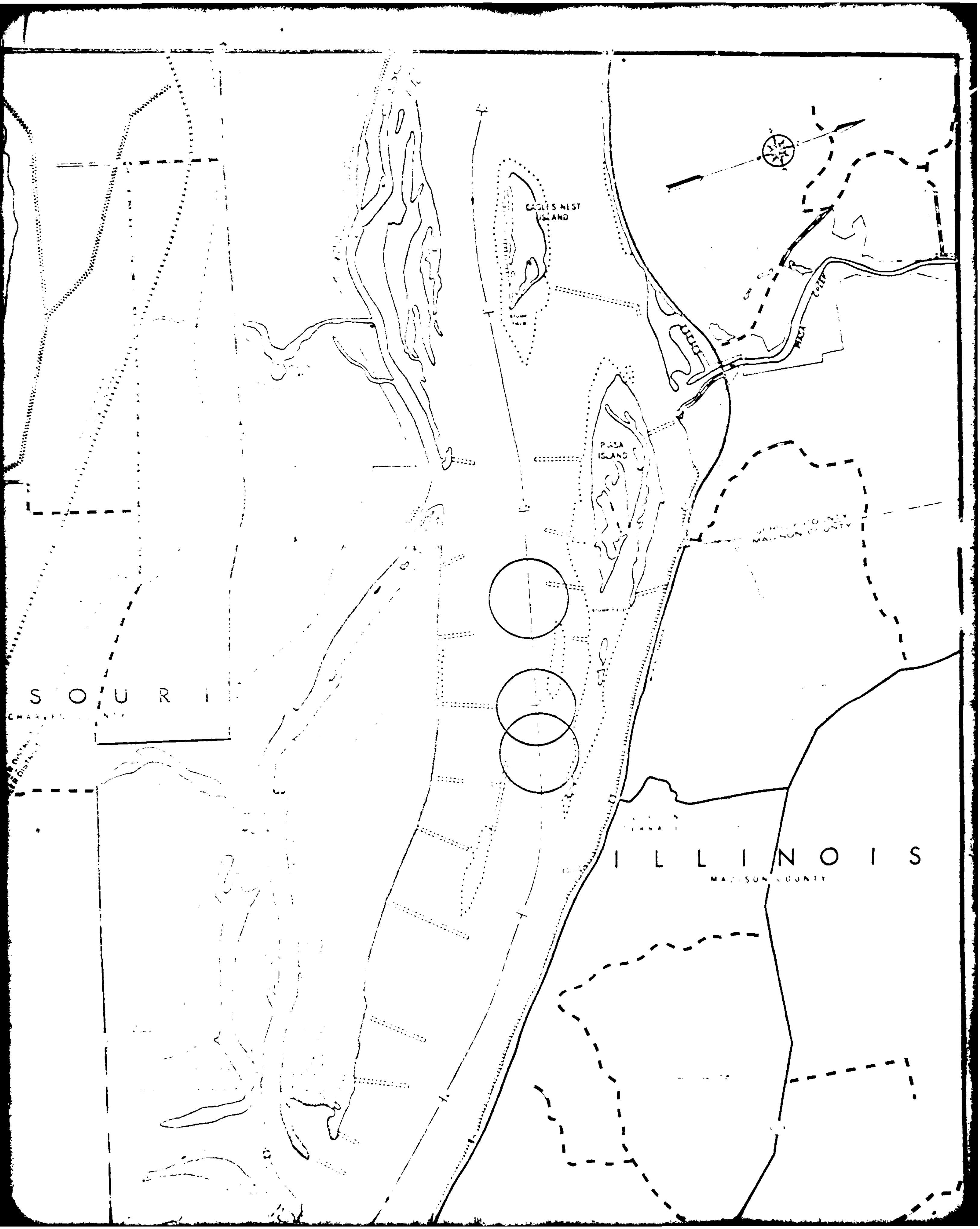
...ver Miles)

Pl...

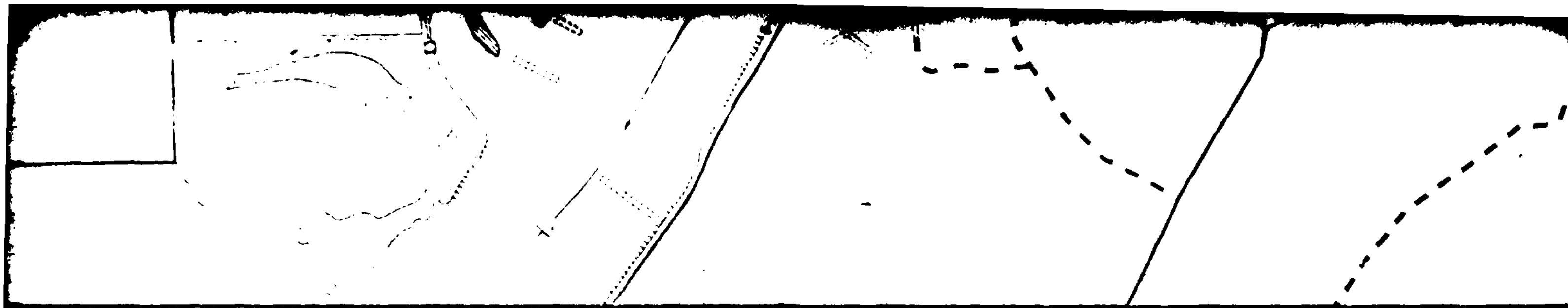
TOTALS [100 c.y.]
0
0
14536
7799
13396
16322
2027
5733
2780
5632
0
737

Lock & Dam

Plate 11



EAGLES NEST ISLAND
PIASA ISLAND
ILLINOIS



LEGEND

5-year projected dredge cuts

Placement capabilities at previous dredge cuts*

* Based on current 950 ft. placement capability of Dredge Kennedy. Plant limitations restrict placement to within 15° of channel and prohibit overbank placement.

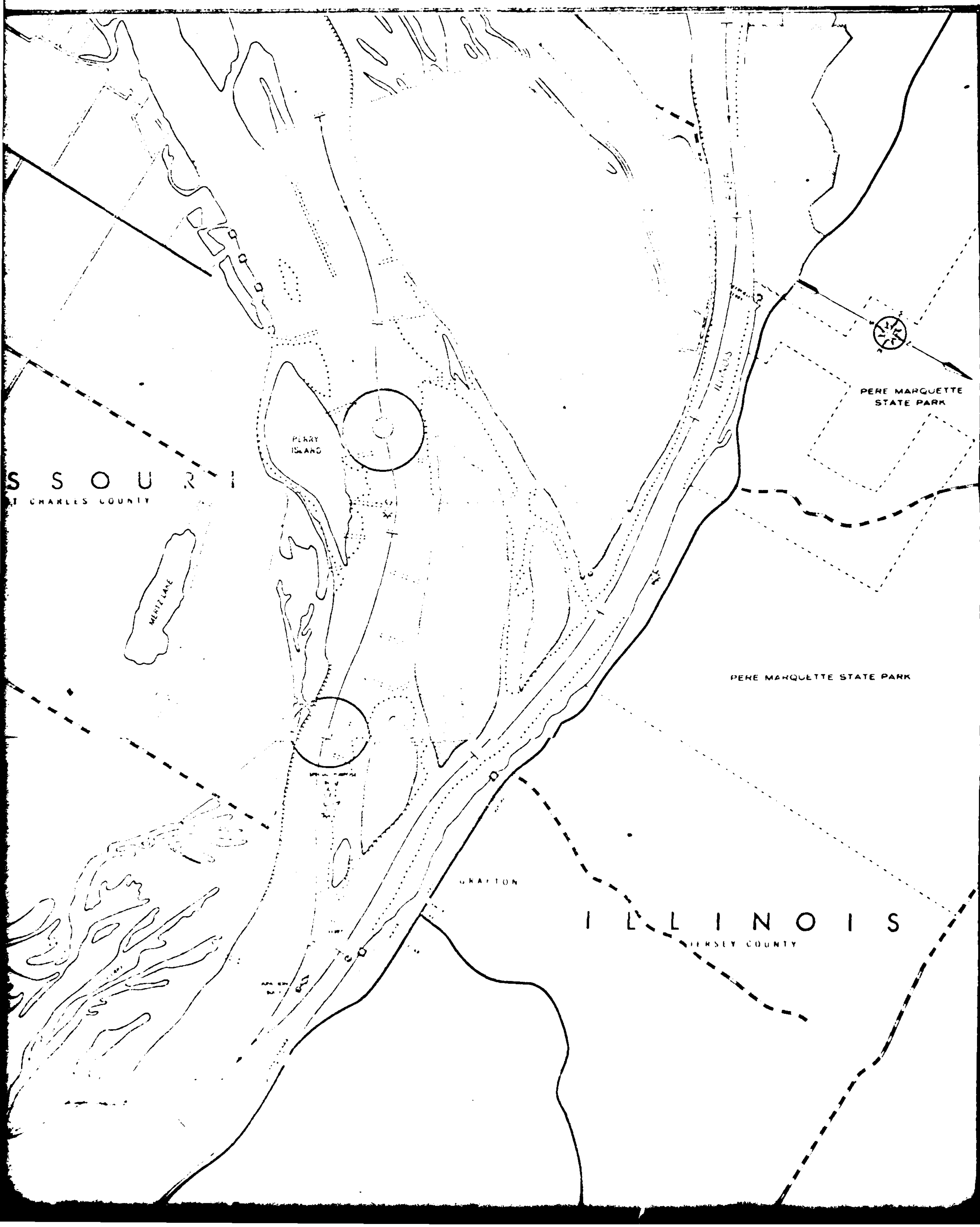
STATUTE MILES

0 2

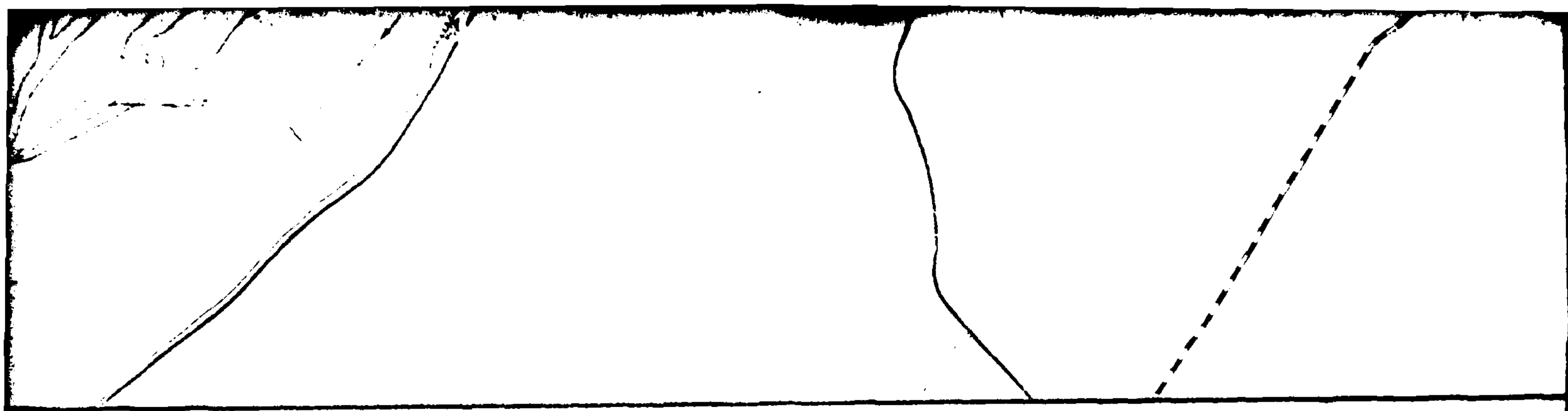
CRITICAL AREA RM 207-209

Future [illegible] in this critical area would be limited to Selective Open Water Placement.

PLATE 12-?



SSOURI
T CHARLES COUNTY
PERRY ISLAND
MERTZ LAKE
PERE MARQUETTE STATE PARK
PERE MARQUETTE STATE PARK
GRAFTON
ILLINOIS
JERSEY COUNTY



LEGEND

5-year projected dredge cuts

Placement capabilities at previous dredge cuts*

* Based on current 950 ft. placement capability of Dredge Kennedy. Plant limitations restrict placement to within 15 of channel and prohibit overbank placement.

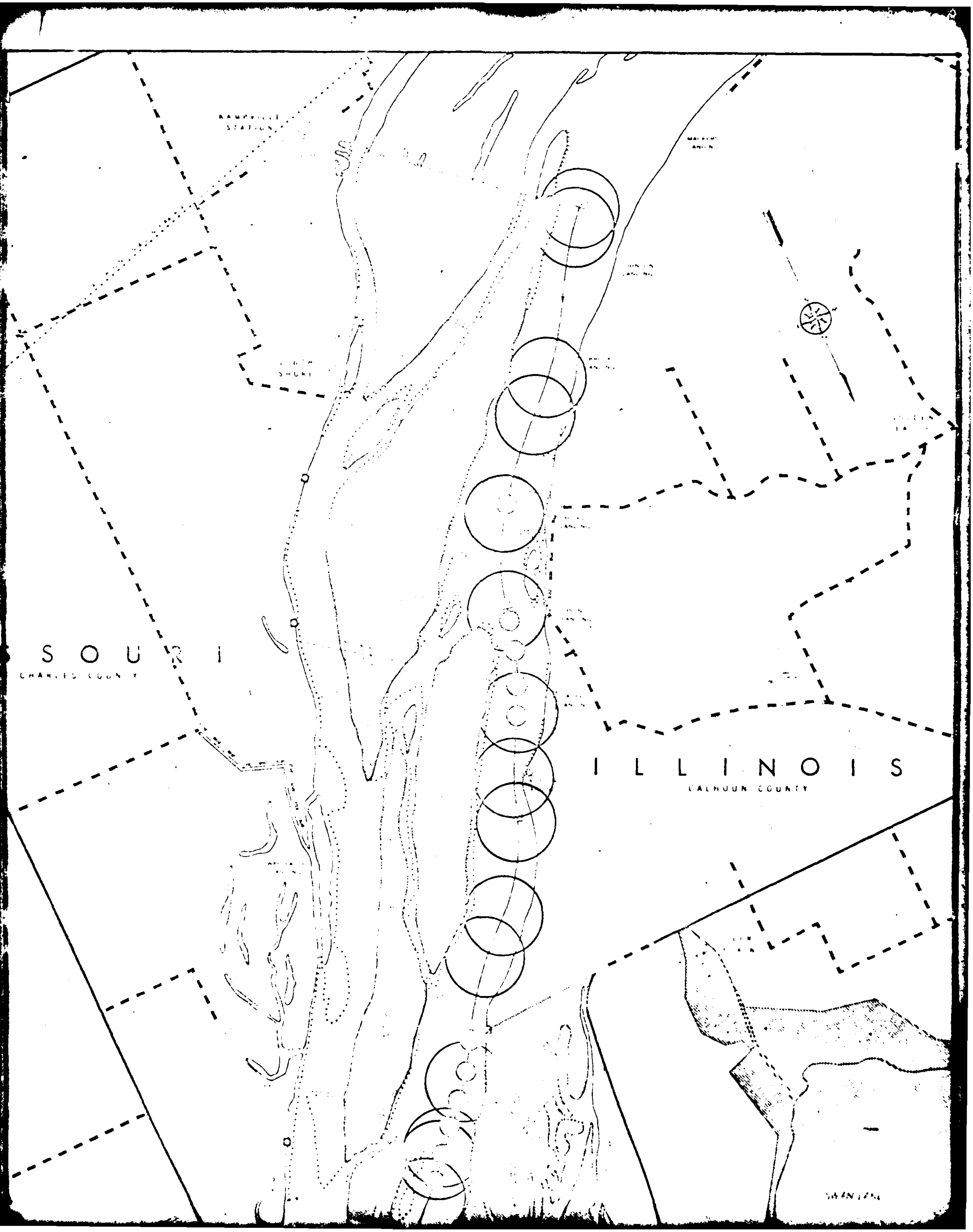
STATUTE MILES

0 1 2

CRITICAL AREA RM 219-220.5

[illegible]

Future dredge material placement in this critical area may be accomplished utilizing Open Water Placement and/or Selective Placement. Selective Placement along the Missouri bank could result in the creation of a sand beach at Perry Island.


SOURI
CHARLES COUNTY
ILLINOIS
CALHOUN COUNTY

LEGEND

5-year projected dredge cuts

Placement capabilities at previous dredge cuts*

* Based on current 950 ft. placement capability of Dredge Kennedy. Plant limitations restrict placement to within 15 of channel and prohibit overbank placement.

STATUTE MILES

0 1 2

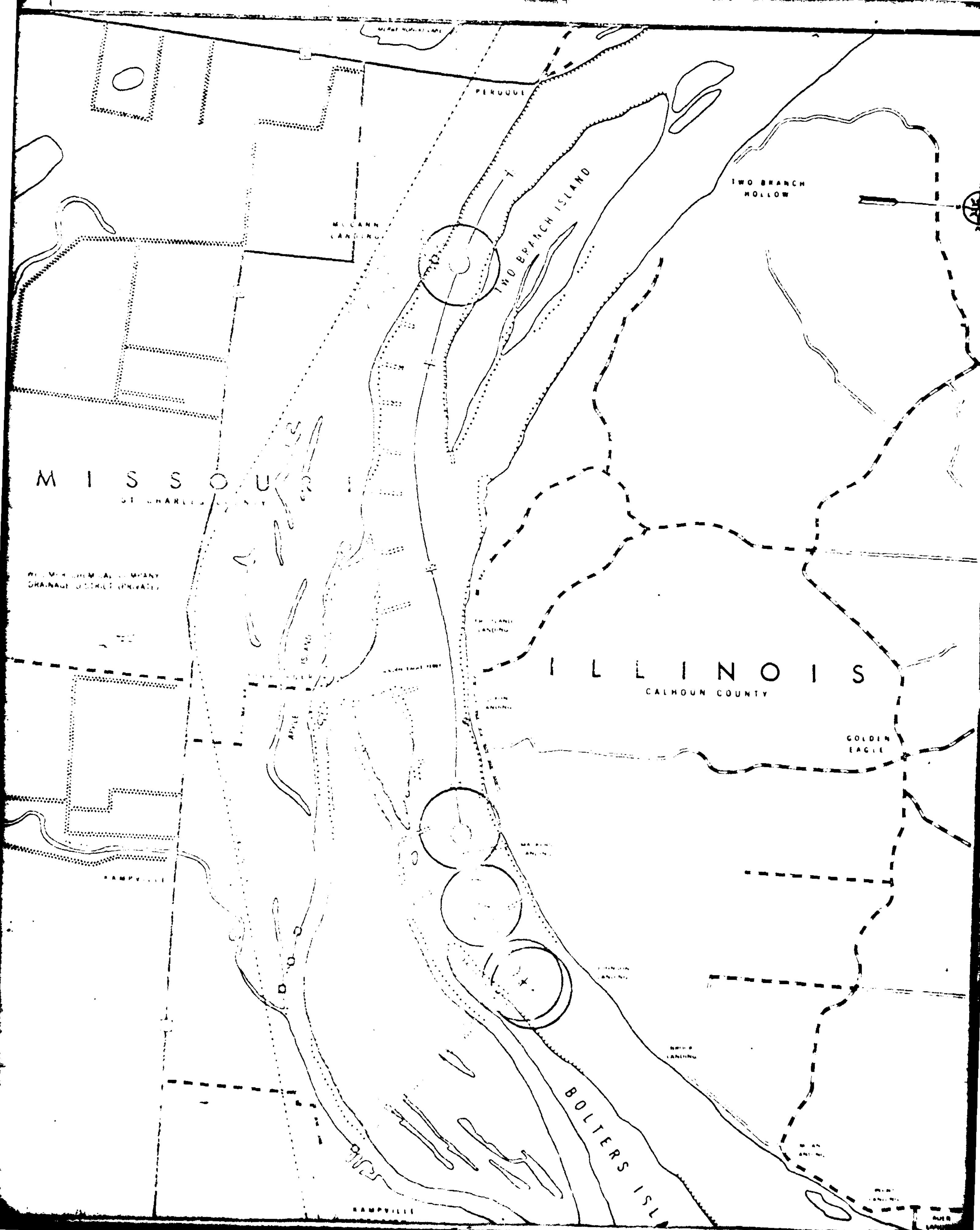
CRITICAL AREA RM 222-227

[illegible]

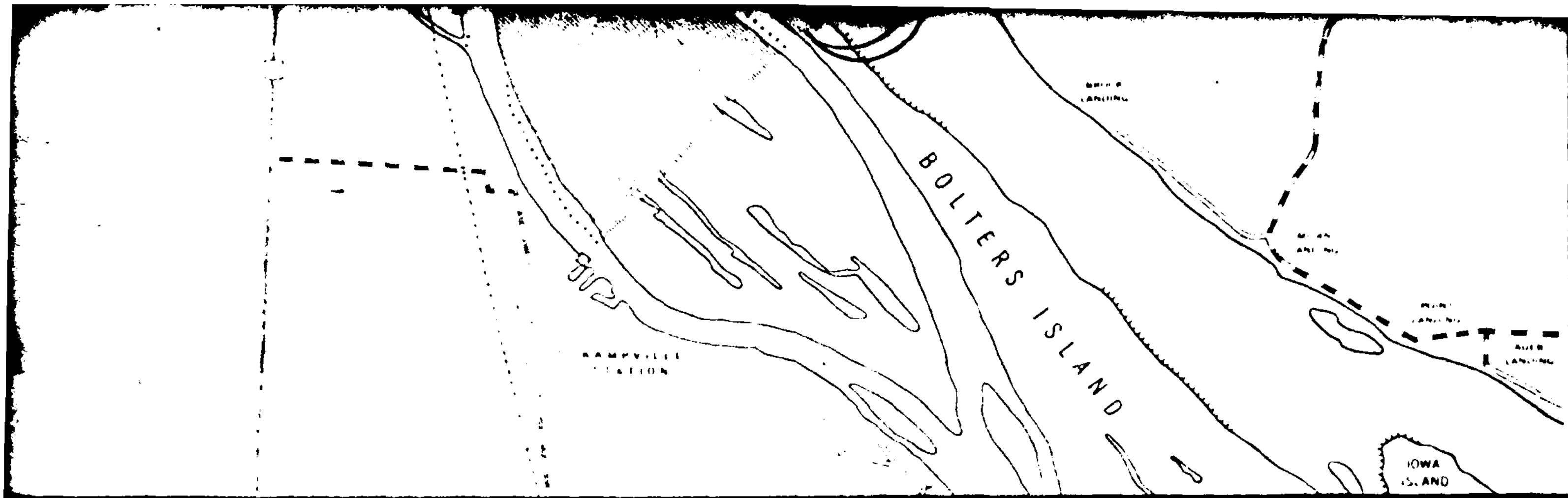
This reach of the river is critical with a portion needing dredging on nearly an annual basis. Previous dredge material placement has consisted of Open Water Placement and Selective Placement along the bank.

Dredge material placed along the bank at Royal Landing (RM [illegible]-223) is being utilized as an intensive recreational area. Material dredged and placed along the Missouri side of the navigation channel is also being utilized for recreation.

For the past two years Calhoun County has removed 6,500 tons of sand annually from Royal Landing. This material is being utilized for Calhoun County's road maintenance program. The St. Louis District has issued Calhoun County a permit to remove [illegible],500 tons of sand annually.



PERUQUE
McCANN LANDING
TWO BRANCH ISLAND
TWO BRANCH HOLLOW
MISSOURI
ILLINOIS
CALHOUN COUNTY
GOLDEN EAGLE
BOLTERS ISL
KAMPVILLE



LEGEND

5-year projected dredge cuts

Placement capabilities at previous dredge cuts*

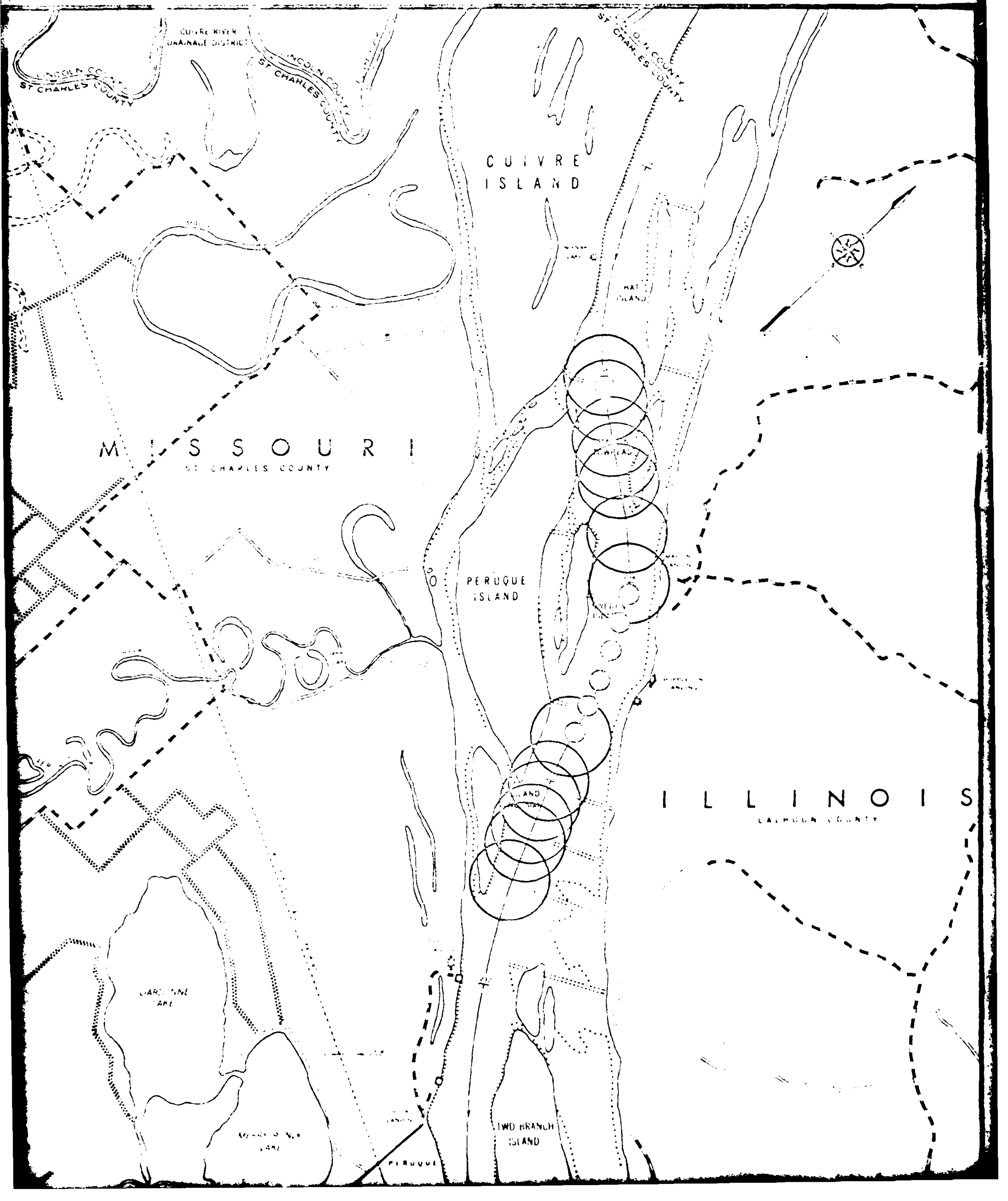
* Based on current 950 ft. placement capability of Dredge Kennedy. Plant limitations restrict placement to within 15° of channel and prohibit overbank placement.

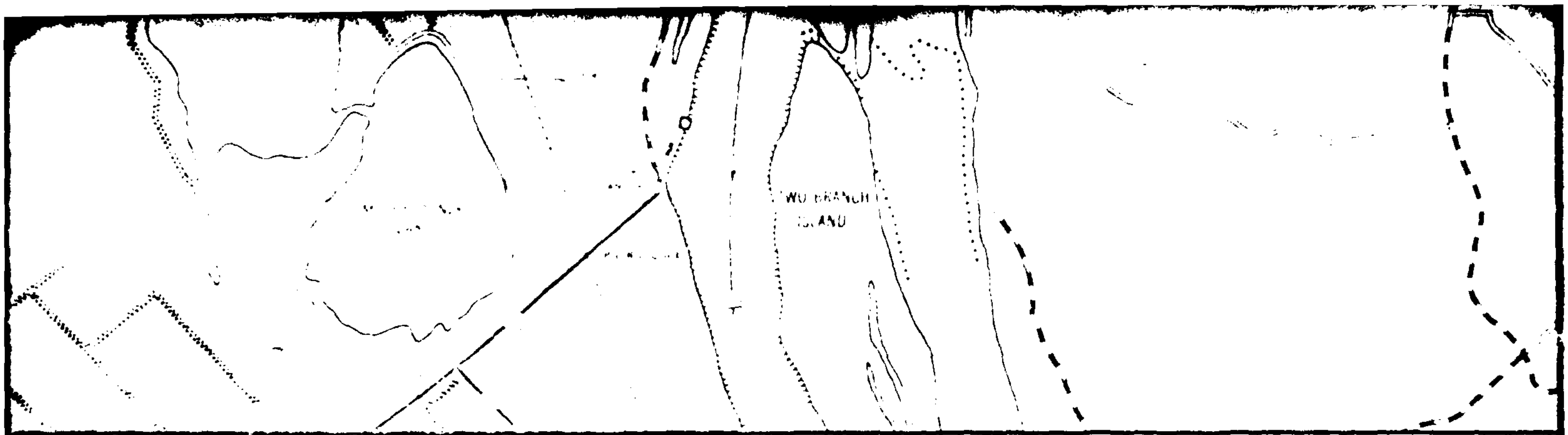
STATUTE MILES

0 1 2

CRITICAL AREA RM 227-228, 230-231

Previous dredge material placement has consisted of Open Water Placement, Selective Placement in the Illinois side of the navigation channel. Future dredge material placement in this critical area will continue to utilize the Open Water and Selective Placement methods. Placement will probably continue to be located on the Illinois side of the navigation channel.


CUIVRE RIVER DRAINAGE DISTRICT
LINCOLN COUNTY
ST CHARLES COUNTY
CUIVRE ISLAND
HAT ISLAND
MISSOURI
ST CHARLES COUNTY
PERUQUE ISLAND
ILLINOIS
CALHOUN COUNTY
TWO BRANCH ISLAND
PERUQUE



LEGEND

5-year projected dredge cuts

Placement capabilities at previous dredge cuts*

* based on current 950 ft. placement capability of Dredge Kennedy. Plant limitations restrict placement to within 15° of channel and prohibit overbank placement.

STATUTE MILES

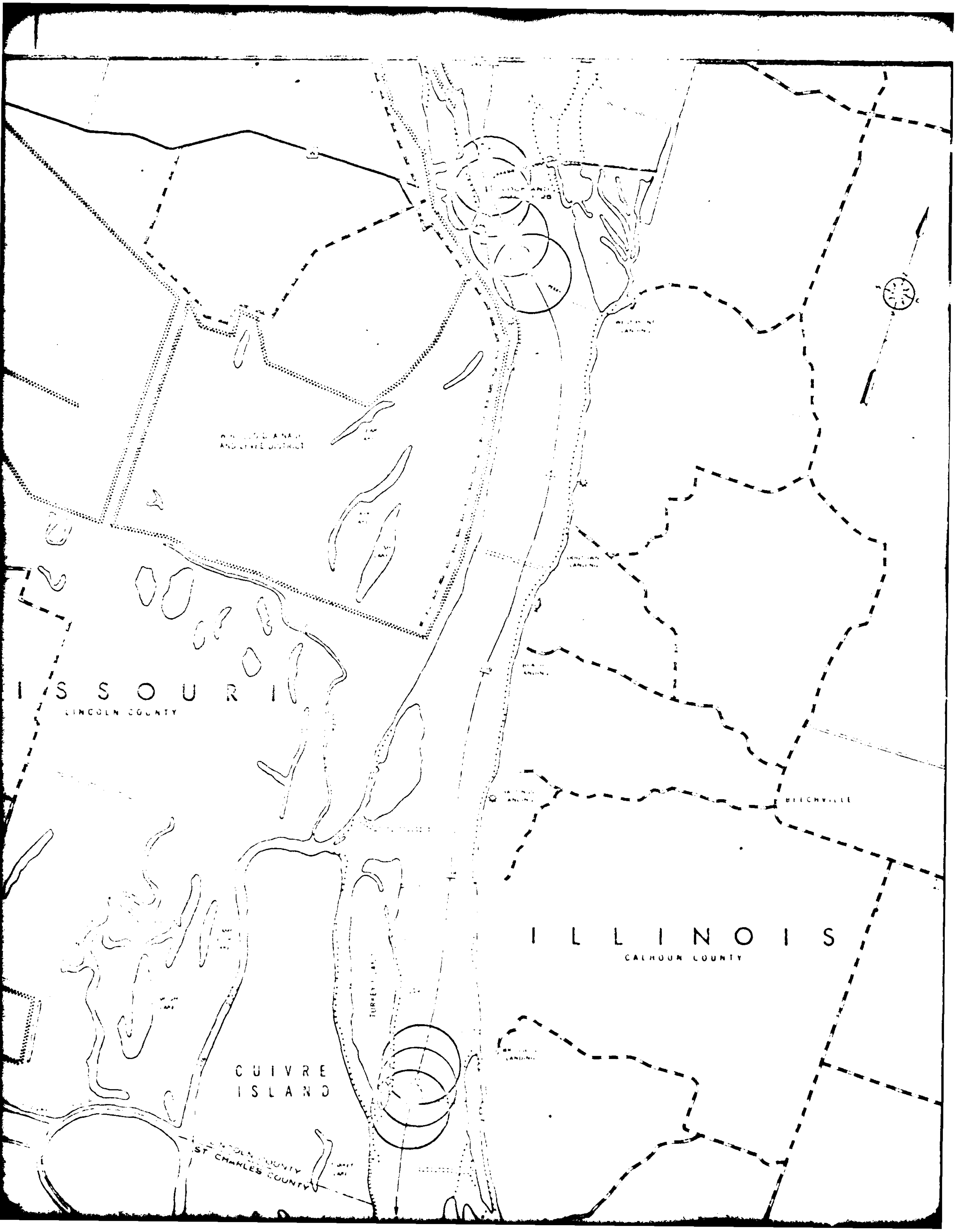
0 1 2

CRITICAL AREA RM 232-235

[illegible]

[illegible] dredge material [illegible] in this critical area would be limited to the Open Water and [illegible] placement method. Previously dredged material has been placed on both the Missouri and Illinois sides of the navigation channel. Sand beaches have been created at Island 508 and the southern end (channel side) of Peruque Island by dredge material placed at these locations.

PLATE 12-E

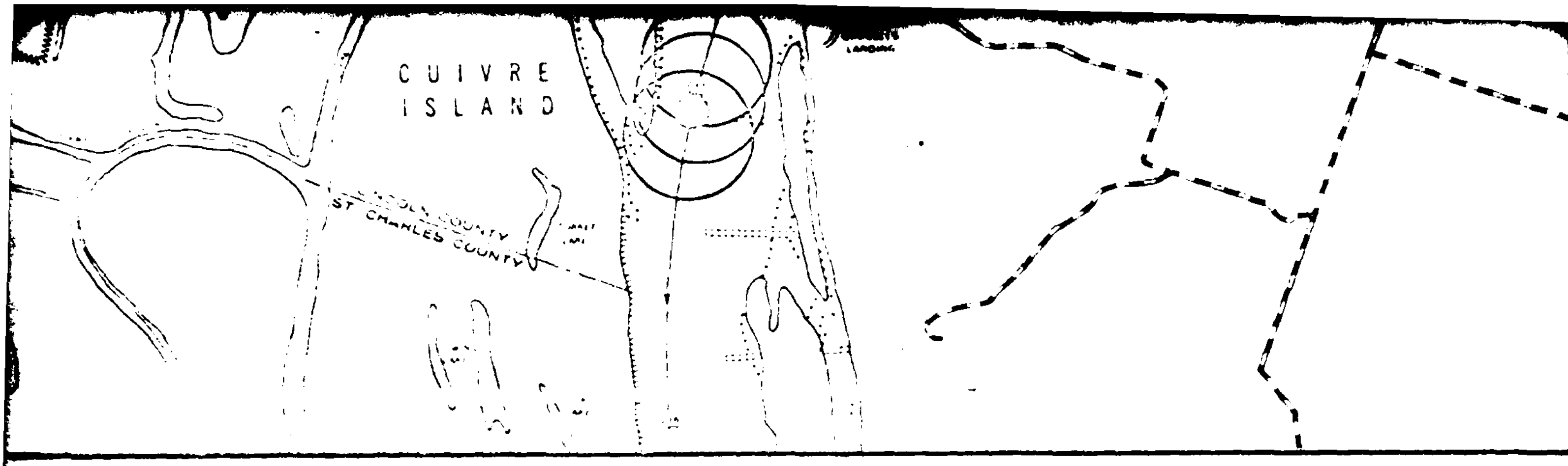

I S S O U R I
LINCOLN COUNTY
I L L I N O I S
CALHOUN COUNTY
C U I V R E
I S L A N D
BEECHVILLE
ST CHARLES COUNTY

AD-A116 667 ARMY ENGINEER DISTRICT ST LOUIS MO F/G 13/2
OPERATION AND MAINTENANCE POOLS 24, 25, AND 26 MISSISSIPPI AND --ETC(U)
SEP 75

UNCLASSIFIED NL

8 OF 8
AD A
116667

END
DATE
FILMED
08-82
DTIC



LEGEND

5-year projected dredge cuts

Placement capabilities at previous dredge cuts*

* Based on current 950 ft. placement capability of Dredge Kennedy. Plant limitations restrict placement to within 15° of channel and prohibit overbank placement.

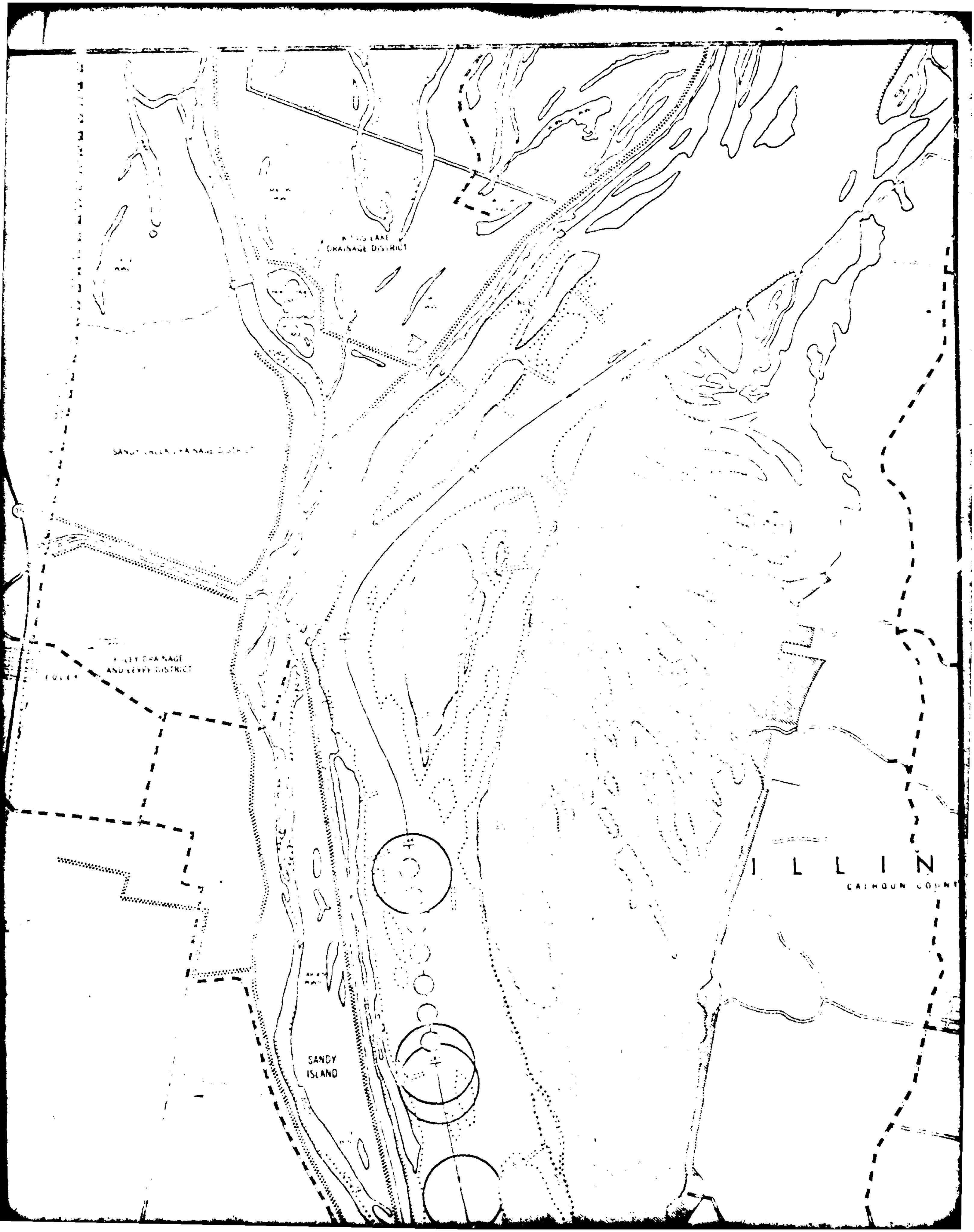
STATUTE MILES

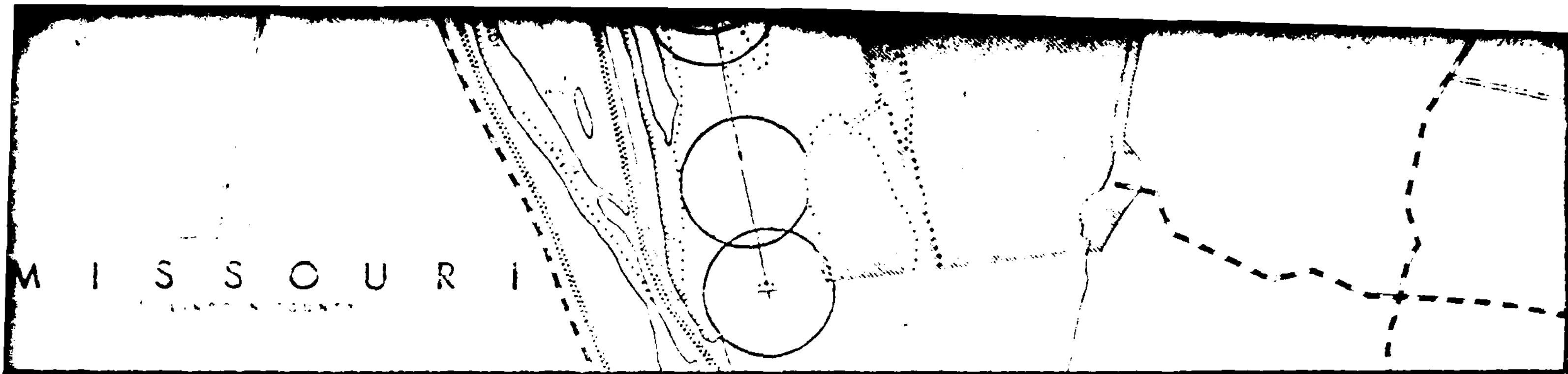
0 1 2

CRITICAL AREA RM 237, 241

[illegible]

[illegible] in the [illegible] critical areas would be limited to the Open Water Placement and Selective Placement methods. Previous material placement has been located on the Illinois side of the navigation channel at RM 237.


DRAINAGE DISTRICT
AND LEVEE DISTRICT
FOLEY
SANDY
ISLAND
I L L I N
CALHOUN COUNT



LEGEND

5-year projected dredge cuts

Placement capabilities at previous dredge cuts*

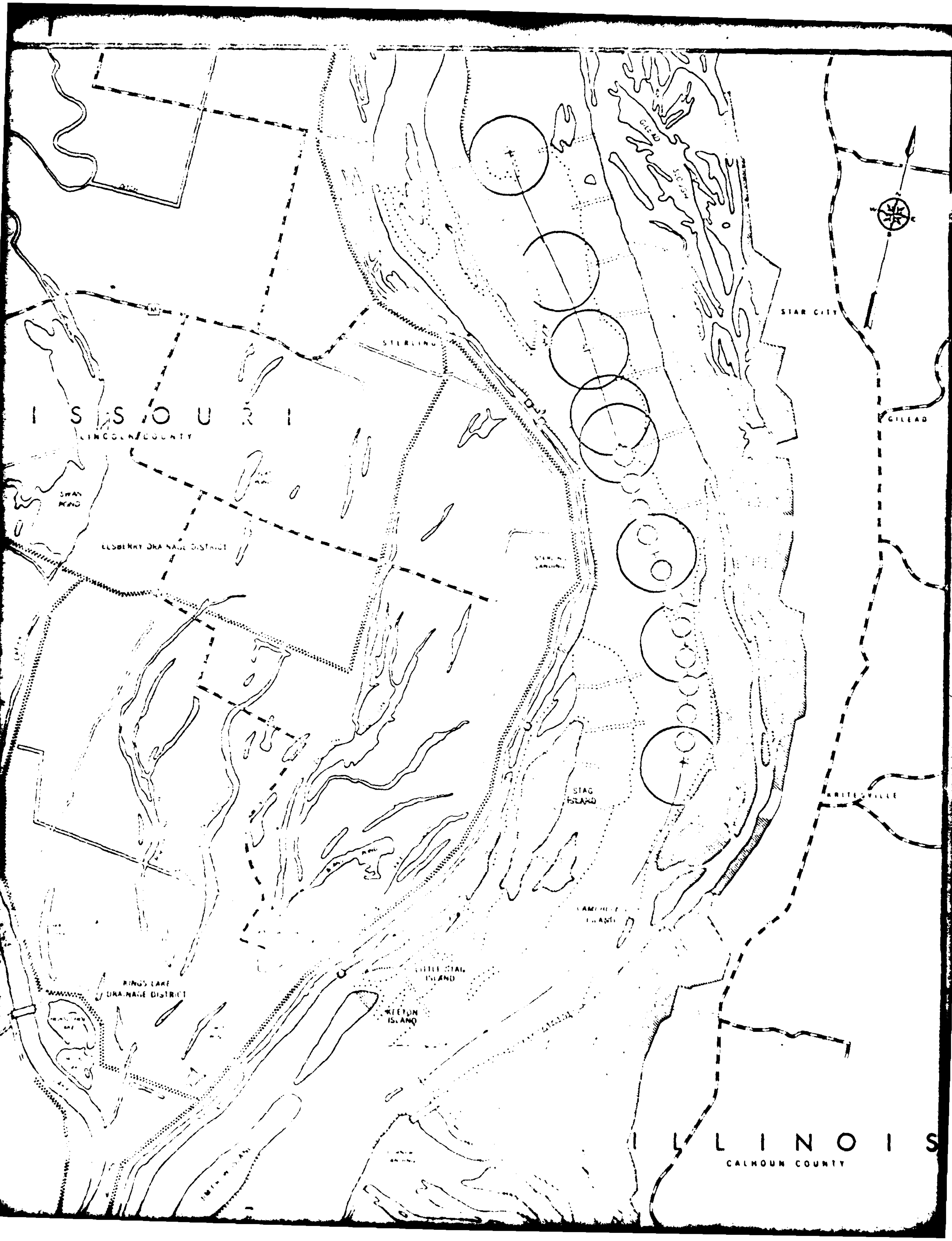
* Based on current 950 ft. placement capability of Dredge Kennedy. Plant limitations restrict placement to within 15° of channel and prohibit overbank placement.

0 1 2

[illegible]

Future dredge material placement in this critical area would utilize most probably the Open Water Placement method. Based on recent dredging activities in this area material placement would probably be on the Illinois side of the navigation channel.

PLATE 12-G



STAR CITY
GILEAD
STERLING
I S S O U R I
LINCOLN COUNTY
ELSBERRY DRAINAGE DISTRICT
STAG ISLAND
LITTLE STAG ISLAND
KEETON ISLAND
KINGS LAKE DRAINAGE DISTRICT
I L L I N O I S
CALHOUN COUNTY

LEGEND

5-year projected dredge cuts

Placement capabilities at previous dredge cuts*

* Based on current 950 ft. placement capability of Dredge Kennedy. Plant limitations restrict placement to within 15° of channel and prohibit overbank placement.

STATUTE MILES

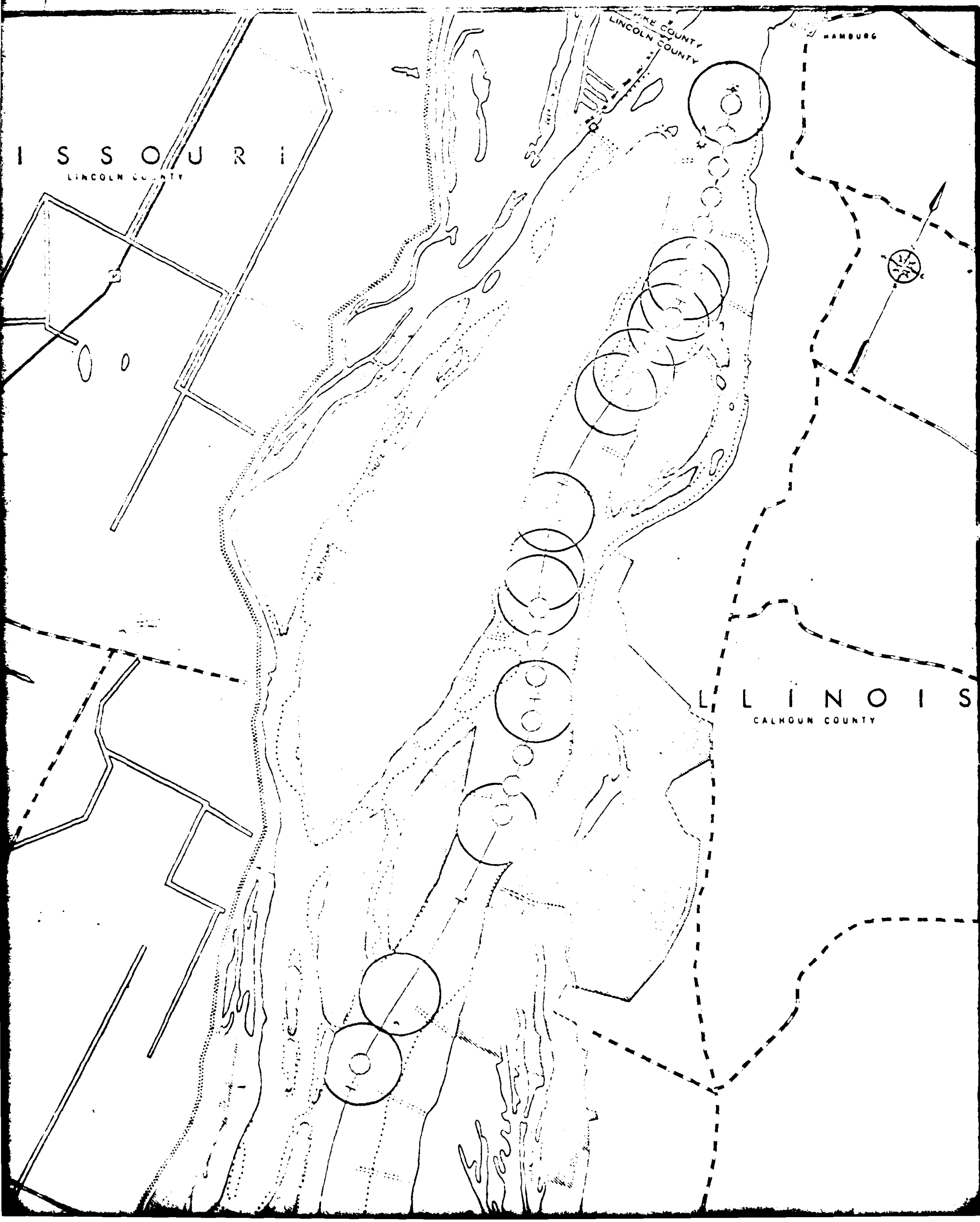
0 1 2

CRITICAL AREA RM 249-252

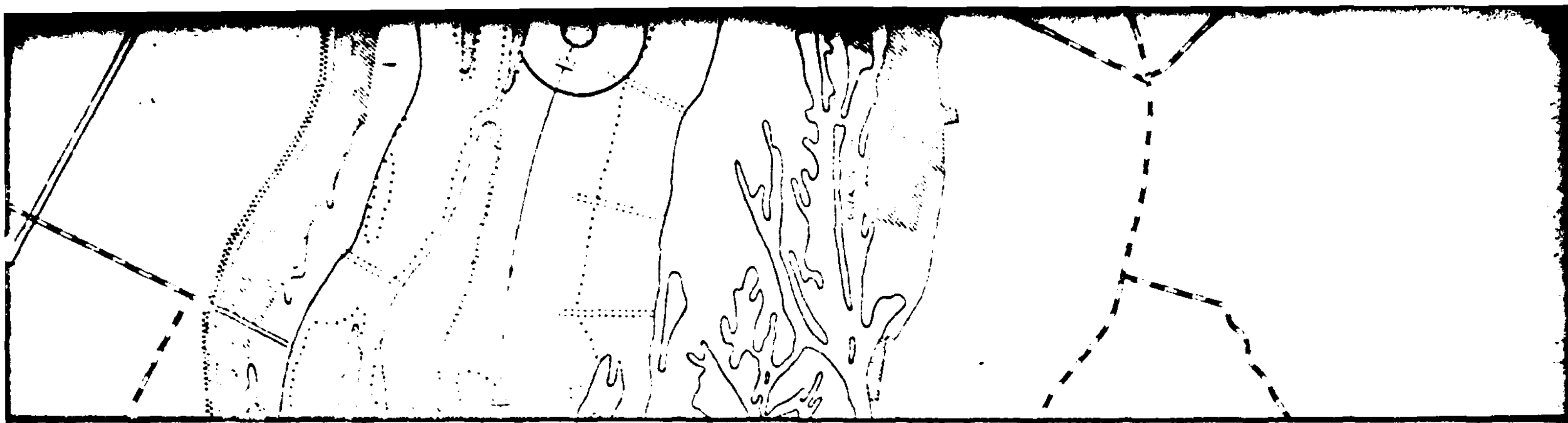
[illegible]

Future dredge material placement in this critical area will probably consist of the Open Water Placement and Selective Placement methods.

PLATE 12-H



ISSOURI
LINCOLN COUNTY
PIKE COUNTY
LINCOLN COUNTY
HAMBURG
ILLINOIS
CALHOUN COUNTY



LEGEND

5-year projected dredge cuts

Placement capabilities at previous dredge cuts*.

* Based on current 950 ft. placement capability of Dredge Kennedy. Plant limitations restrict placement to within 15° of channel and prohibit overbank placement.

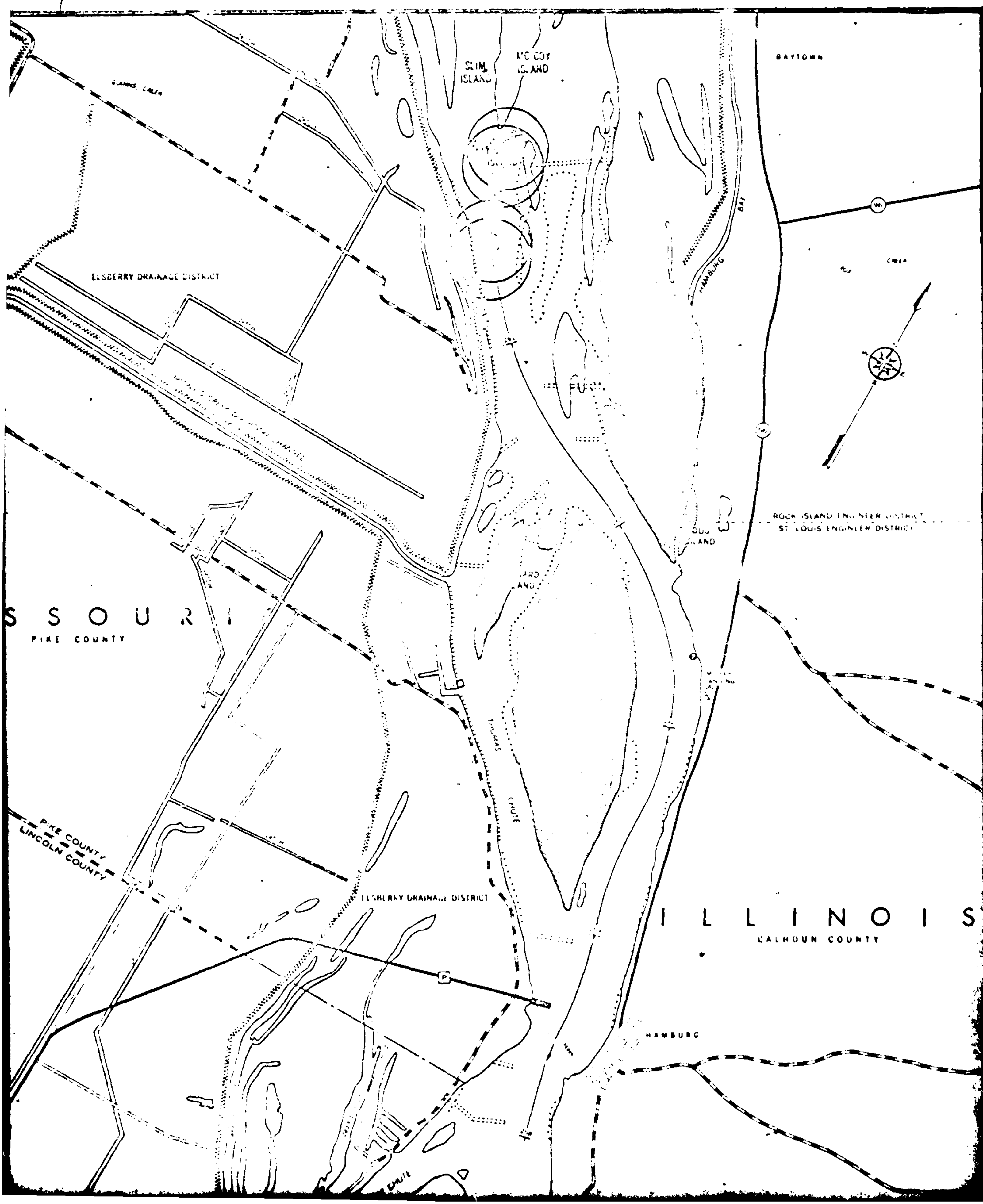
SCALE IN MILES

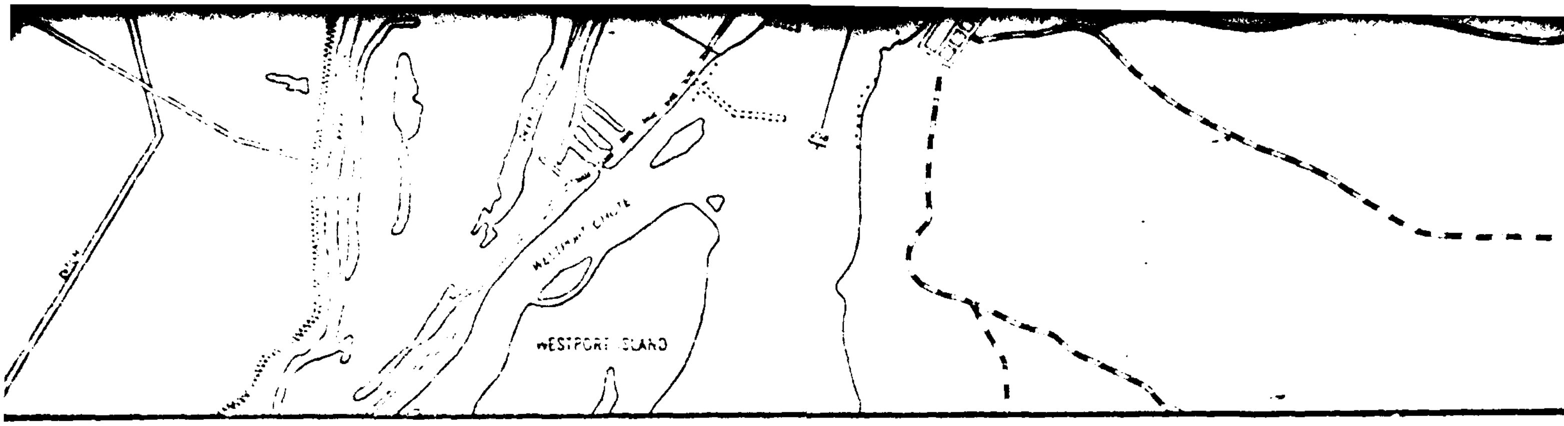
0 1 2

CRITICAL AREA RM 253-255

[illegible]

Future dredge material placement in this critical area will probably consist of the Open Water Placement and Selective Placement methods.


SLIM ISLAND
McCOY ISLAND
BAYTOWN
ELSBERRY DRAINAGE DISTRICT
HAMBURG BAY
ROCK ISLAND ENGINEER DISTRICT
ST. LOUIS ENGINEER DISTRICT
S S O U R I
PIKE COUNTY
THOMAS
CHUTE
PIKE COUNTY
LINCOLN COUNTY
ELSBERRY DRAINAGE DISTRICT
I L L I N O I S
CALHOUN COUNTY
HAMBURG
CHUTE



LEGEND

5-year projected dredge cuts

Placement capabilities at previous dredge cuts*

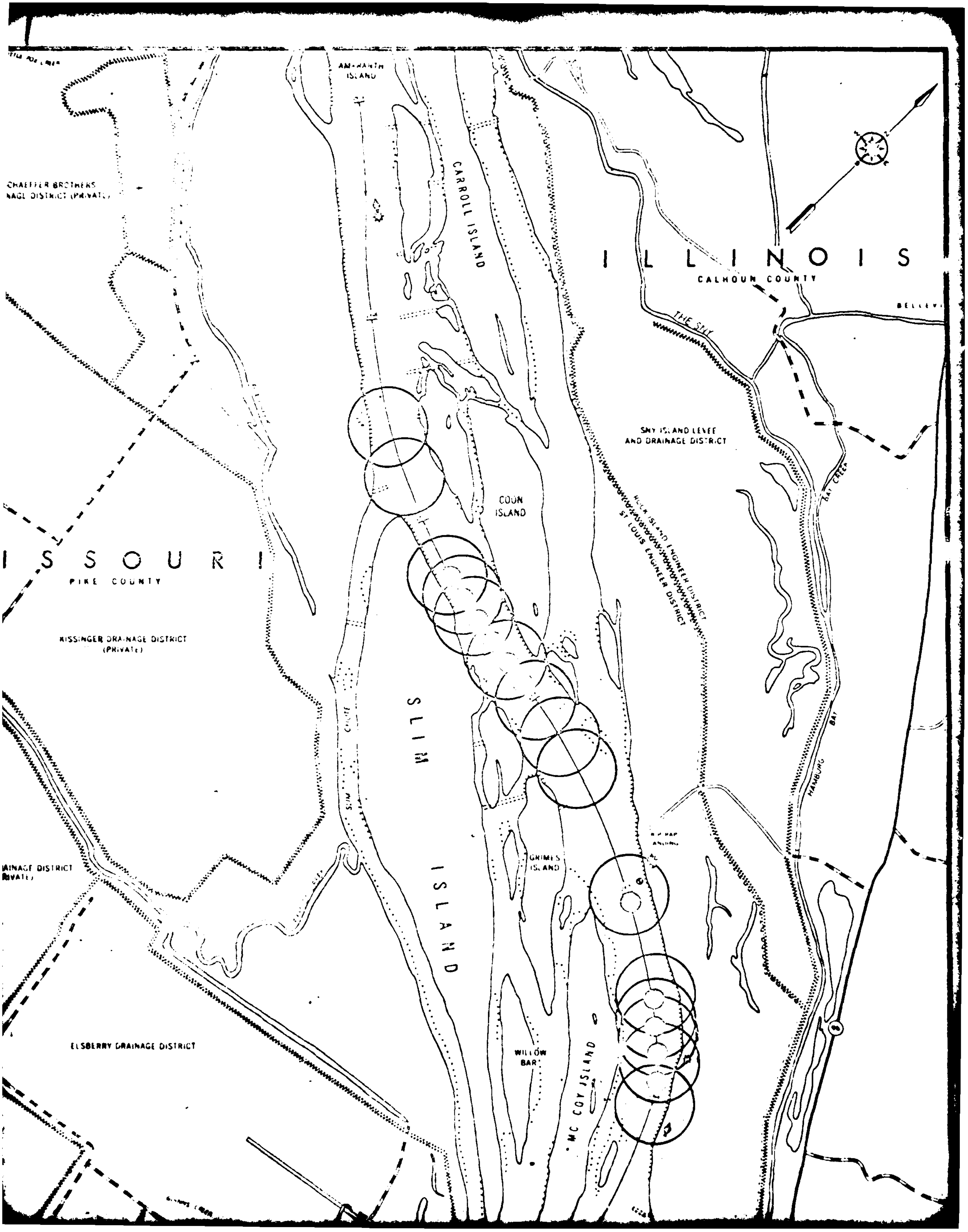
* Based on current 950 ft. placement capability of Dredge Kennedy. Plant limitations restrict placement to within 15° of channel and prohibit overbank placement.

STATUTE MILES

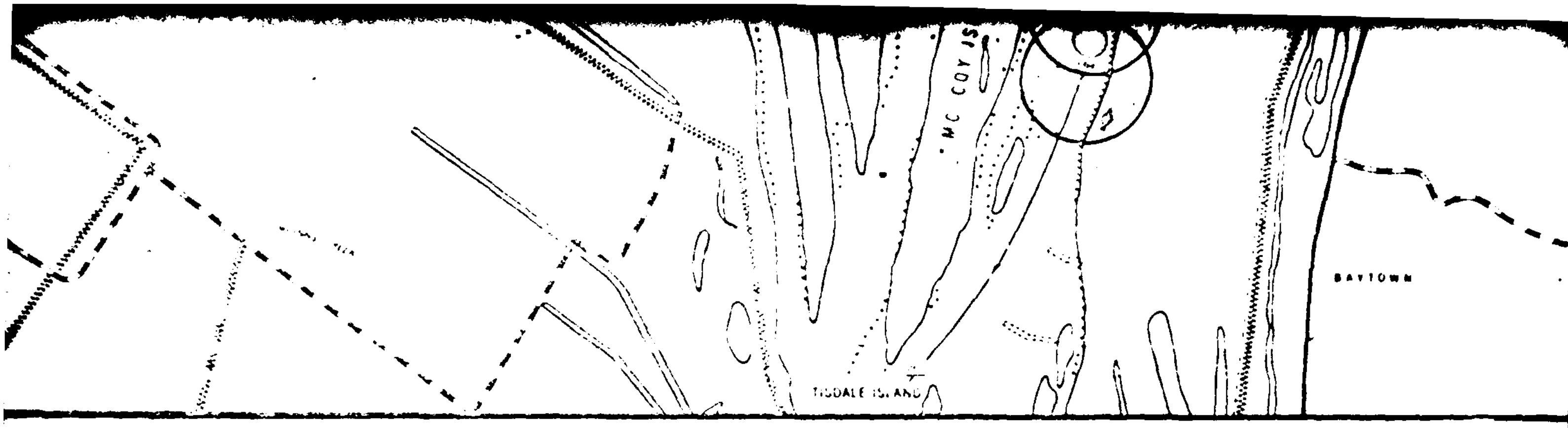
0 1 2

CRITICAL AREA RM 262-263

Future dredge material placement in this critical area will probably consist of the Open Water Placement and the Selective Placement methods.



AMARANTH ISLAND
CHAEFFER BROTHERS
NAGE DISTRICT (PRIVATE)
CARROLL ISLAND
ILLINOIS
CALHOUN COUNTY
THE SNY
SNY ISLAND LEVEE
AND DRAINAGE DISTRICT
BAY CREEK
COON
ISLAND
ROCK ISLAND ENGINEER DISTRICT
ST LOUIS ENGINEER DISTRICT
ISSOURI
PIKE COUNTY
KISSINGER DRAINAGE DISTRICT
(PRIVATE)
SLIM
ISLAND
HAMBURG
BAY
GRIMES
ISLAND
AINAGE DISTRICT
RIVATE)
ELSBERRY DRAINAGE DISTRICT
WILLOW
BAR
MC COY ISLAND



LEGEND

5-year projected dredge cuts

Placement capabilities at previous dredge cuts*

* Based on current 950 ft. placement capability of Dredge Kennedy. Plant limitations restrict placement to within 15° of channel and prohibit overbank placement.

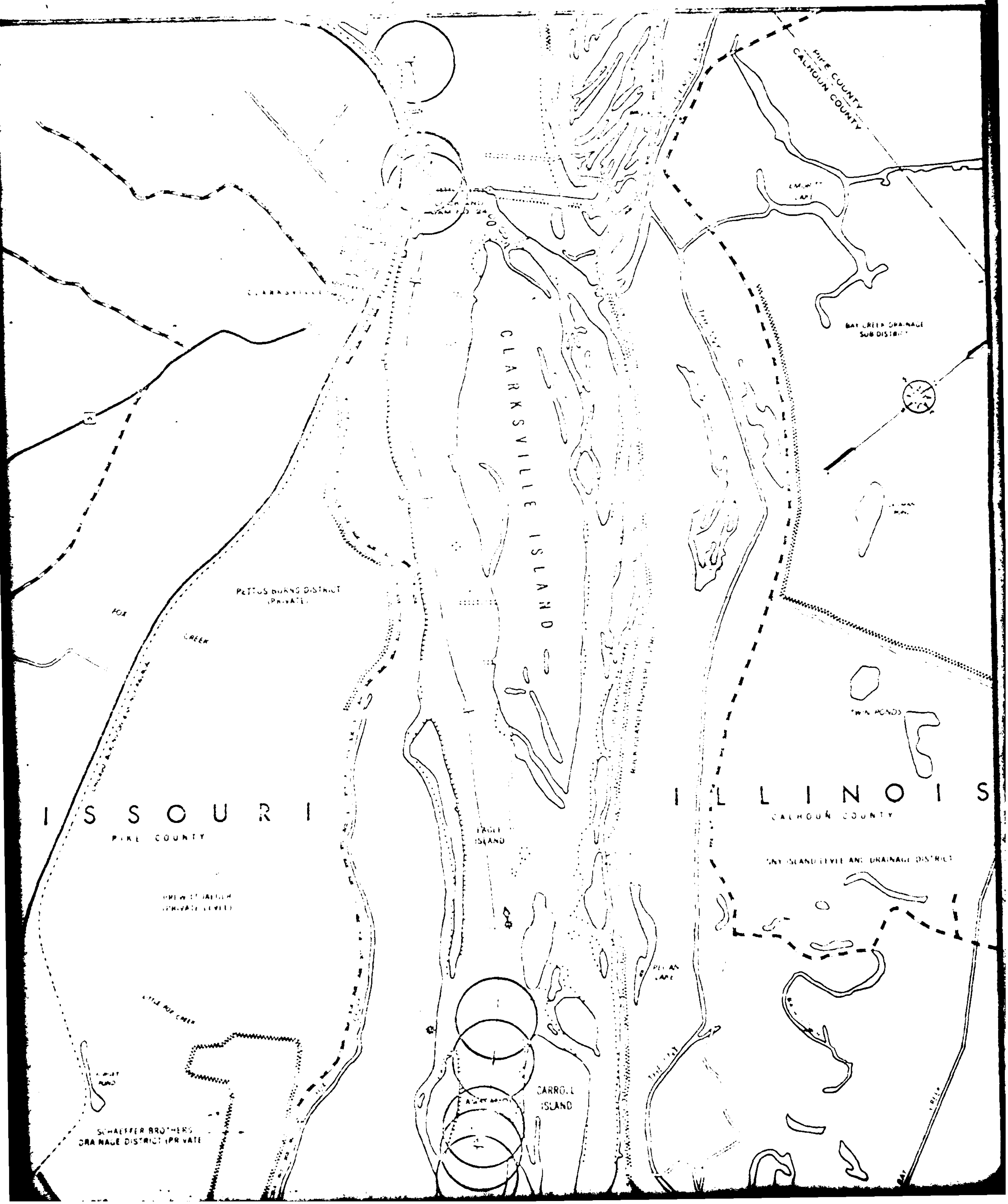
STATUTE MILES

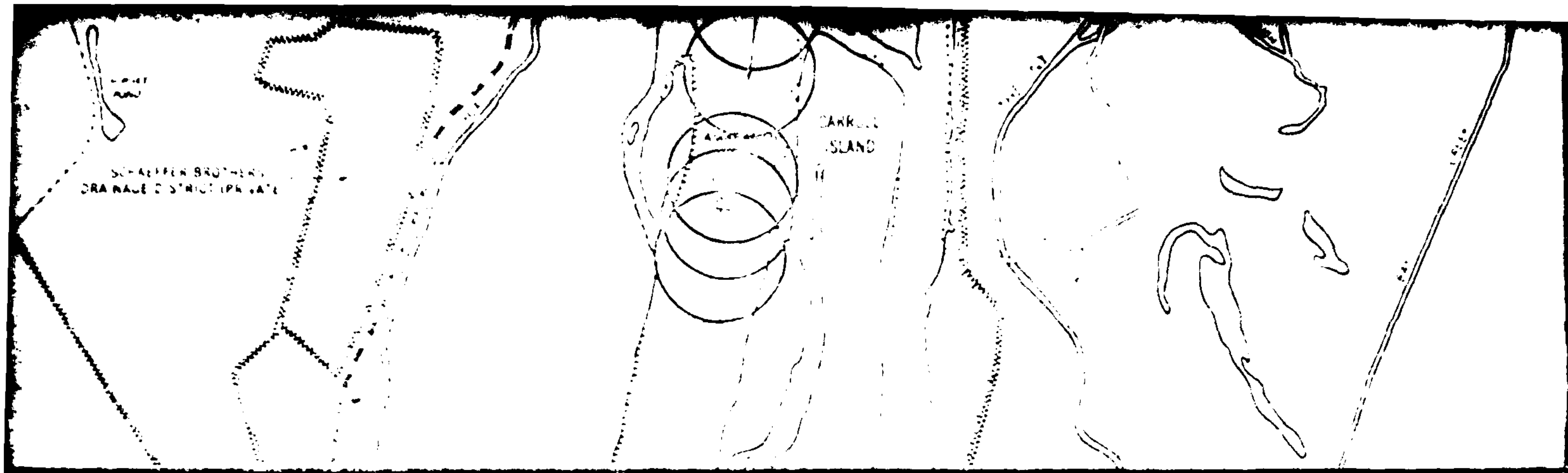
0 1 2

CRITICAL AREA RM 264-267.5

A. [illegible]

Future dredge material placement in this critical area will probably consist of the Open Water Placement and Selective Placement methods.


PIKE COUNTY
CALHOUN COUNTY
BAY CREEK DRAINAGE SUB DISTRICT
CLARKSVILLE
CLARKSVILLE ISLAND
PETTUS BURNS DISTRICT (PRIVATE)
FOX
CREEK
ISSOURI
PIKE COUNTY
EAGLE ISLAND
ILLINOIS
CALHOUN COUNTY
TWIN PONDS
SNY ISLAND LEVEE AND DRAINAGE DISTRICT
PELICAN LAKE
CARROLL ISLAND
LITTLE POF CREEK
SCHAEFFER BROTHERS DRAINAGE DISTRICT (PRIVATE)



LEGEND

5-year projected dredge cuts

Placement capabilities at previous dredge cuts*

* Based on current 950 ft. placement capability of Dredge Kennedy. Plant limitations restrict placement to within 15° of channel and prohibit overbank placement.

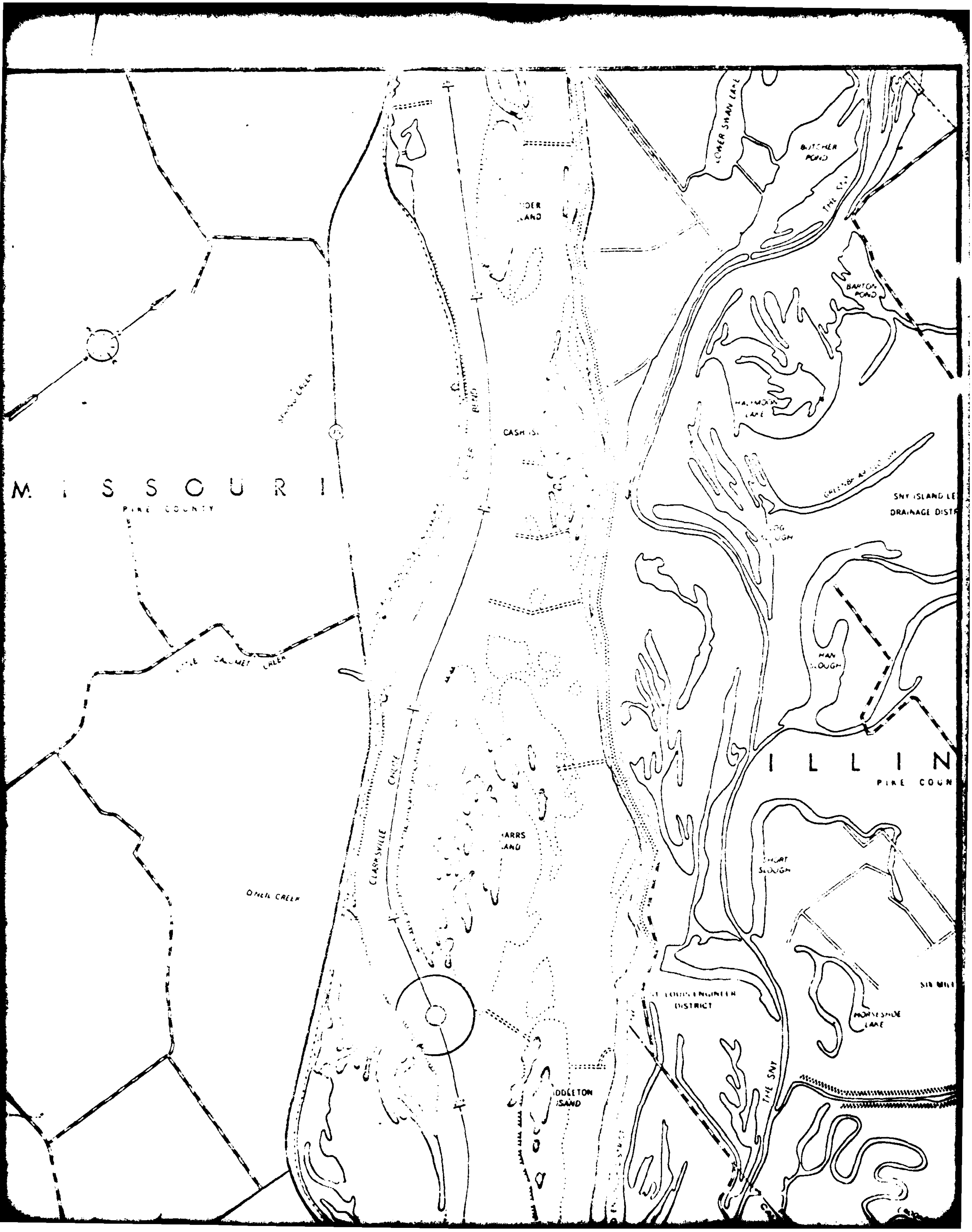
SCALE IN MILES

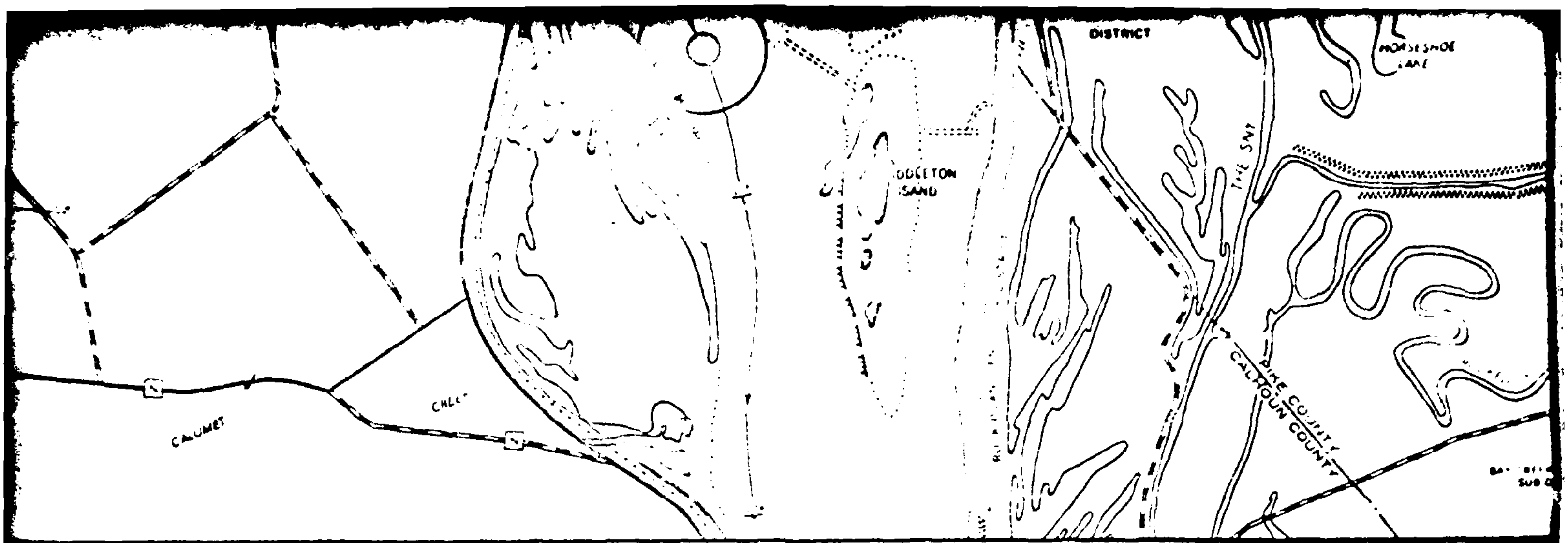
0 1 2

[illegible]

[illegible]

Future dredge material placement in these critical areas will probably consist of the Open Water Placement and Selective Placement methods.


MISSOURI
PIKE COUNTY
ONEIL CREEK
CLARKSVILLE CHUTE
BUTCHER POND
THE SNY
BARTON POND
SNY ISLAND LE
DRAINAGE DISTR
ILLIN
PIKE COUN
SHORT SLOUGH
ST LOUIS ENGINEER DISTRICT
HORSESHOE LAKE
THE SNY



LEGEND

5-year projected dredge cuts

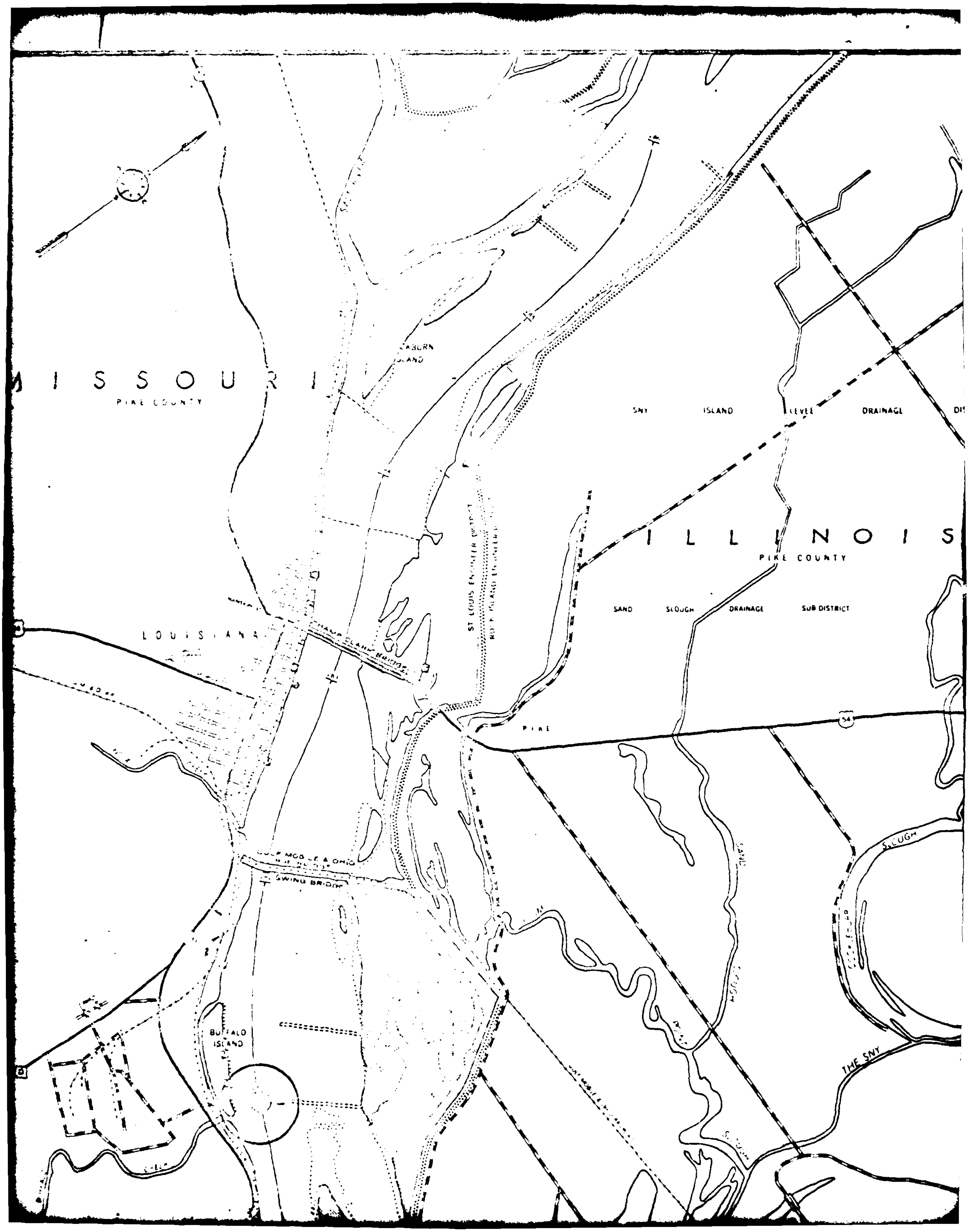
Placement capabilities at previous dredge cuts*

* Based on current 950 ft. placement capability of Dredge Kennedy. Plant limitations restrict placement to within 15° of channel and prohibit overbank placement.

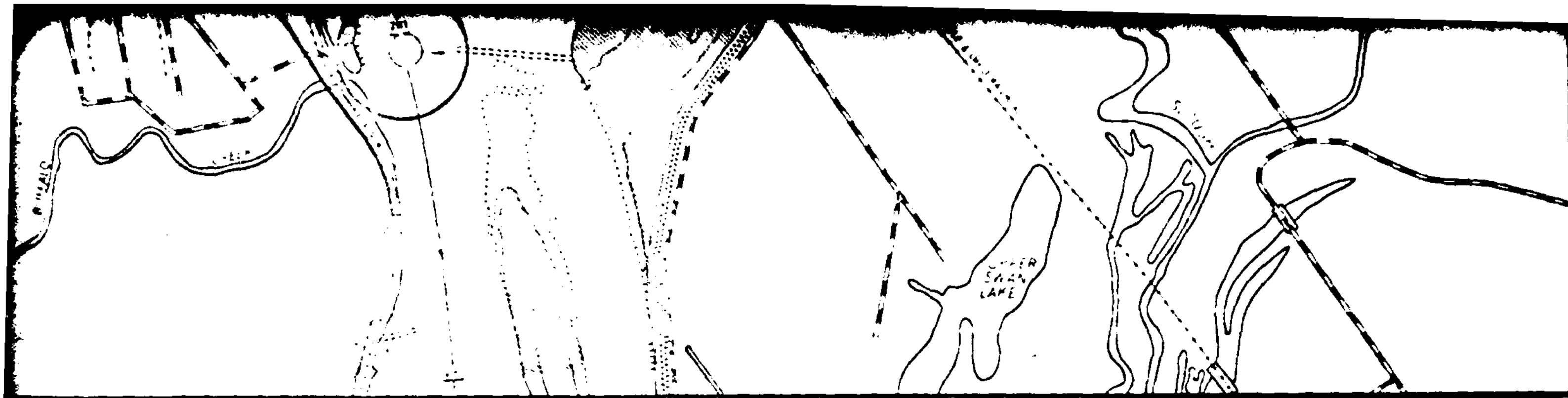
STATUTE MILES 0 1 2

CRITICAL AREA RM 275.5

Future dredge material placement at this critical area will probably consist of the Open Water Placement and Selective Placement methods.



MISSOURI
PIKE COUNTY
LOUISIANA
SWING BRIDGE
BUFFALO ISLAND
ILLINOIS
PIKE COUNTY
SNY ISLAND LEVEE DRAINAGE DIS
SAND SLOUGH DRAINAGE SUB DISTRICT
ST LOUIS ENGINEER DISTRICT
ROCK ISLAND ENGINEER DISTRICT
PIKE
54
SLOUGH
THE SNY
SAND



LEGEND

5-year projected dredge cuts

Placement capabilities at previous dredge cuts*

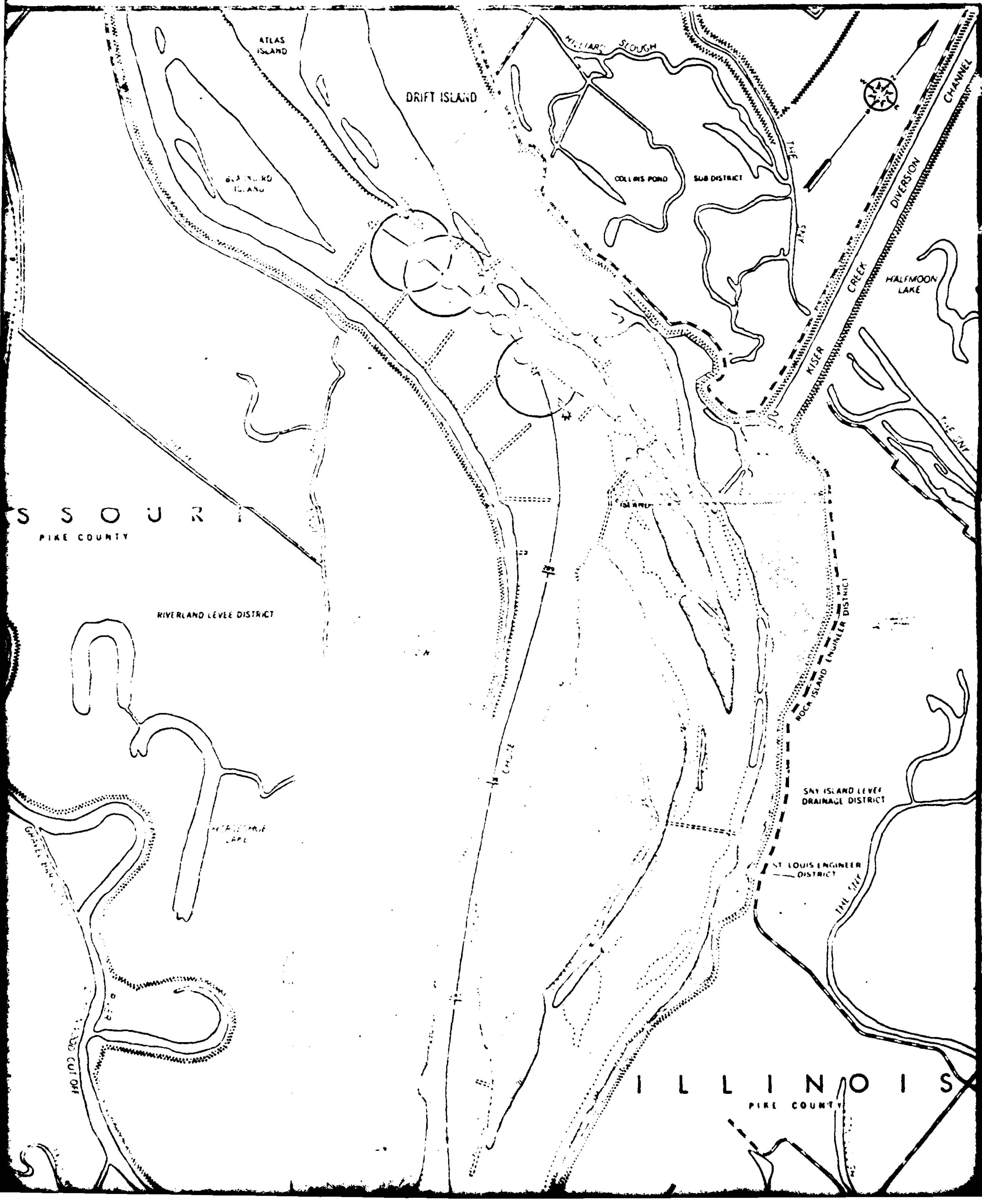
* Based on current 950 ft. placement capability of Dredge Kennedy. Plant limitations restrict placement to within 15 of channel and prohibit overbank placement.

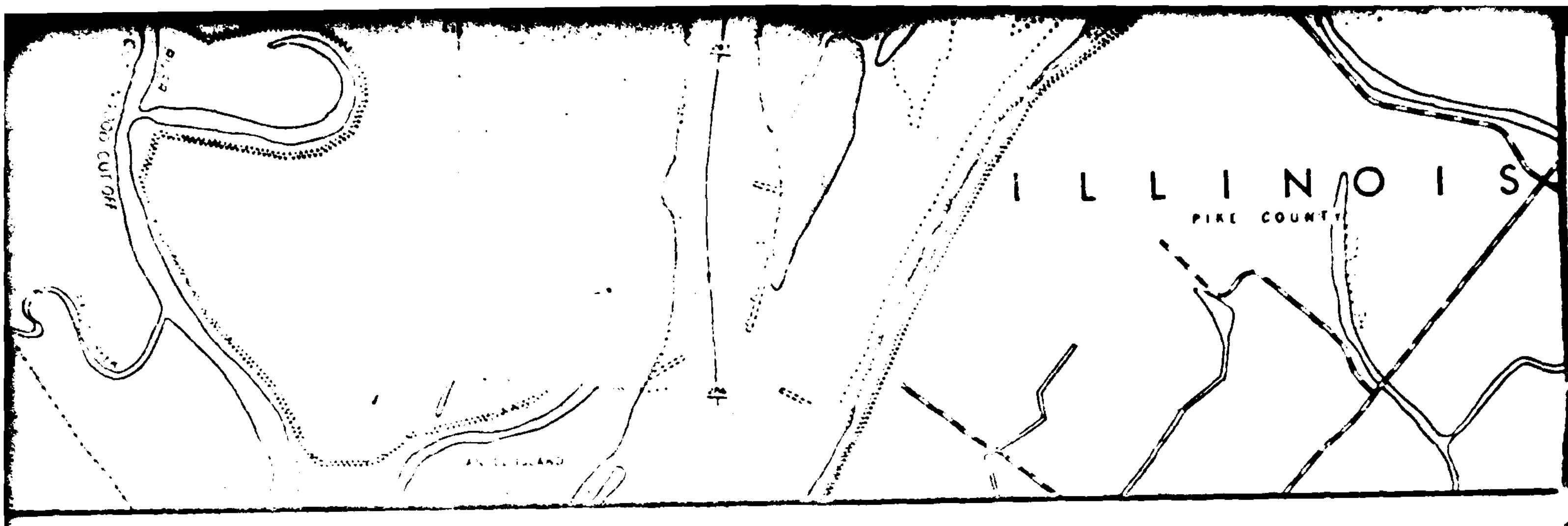
STATUTE MILES

0 1 2

ALTERNATIVES

Future dredge material placement in this critical area will probably consist of the Open Water Placement and Selective Placement methods.


ATLAS ISLAND
DRIFT ISLAND
COLLINS POND
SUB DISTRICT
KISER CREEK DIVERSION CHANNEL
HALFMOON LAKE
MISSOURI
PIKE COUNTY
RIVERLAND LEVEE DISTRICT
ROCK ISLAND ENGINEER DISTRICT
SNY ISLAND LEVEE DRAINAGE DISTRICT
ST. LOUIS ENGINEER DISTRICT
THE SNY
ILLINOIS
PIKE COUNTY



LEGEND*

5-year projected dredge cuts

Placement capabilities at previous dredge cuts*

* Based on current 950 ft. placement capability of Dredge Kennedy. Plant limitations restrict placement to within 15° of channel and prohibit overbank placement.

STATUTE MILES

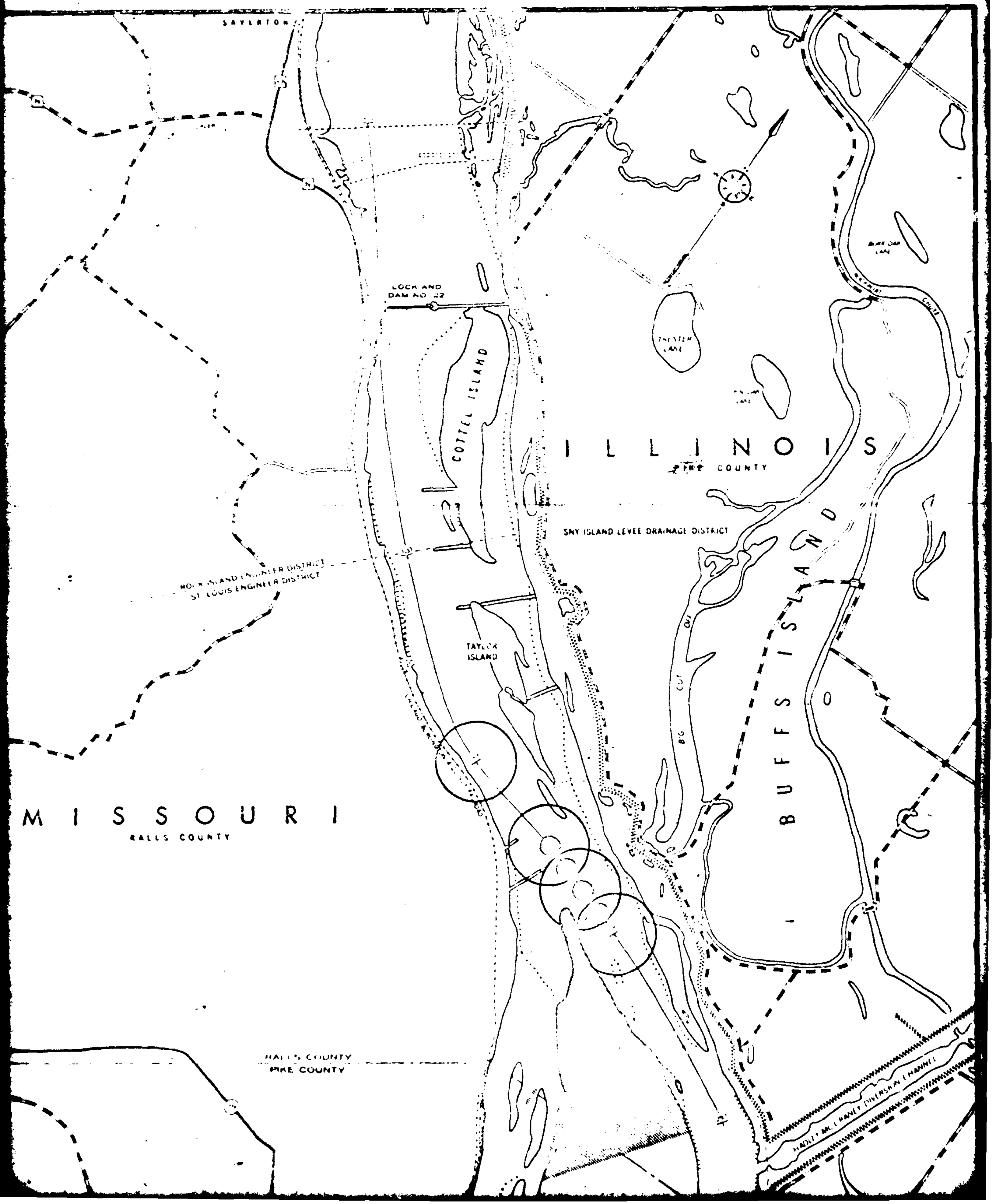
0 1 2

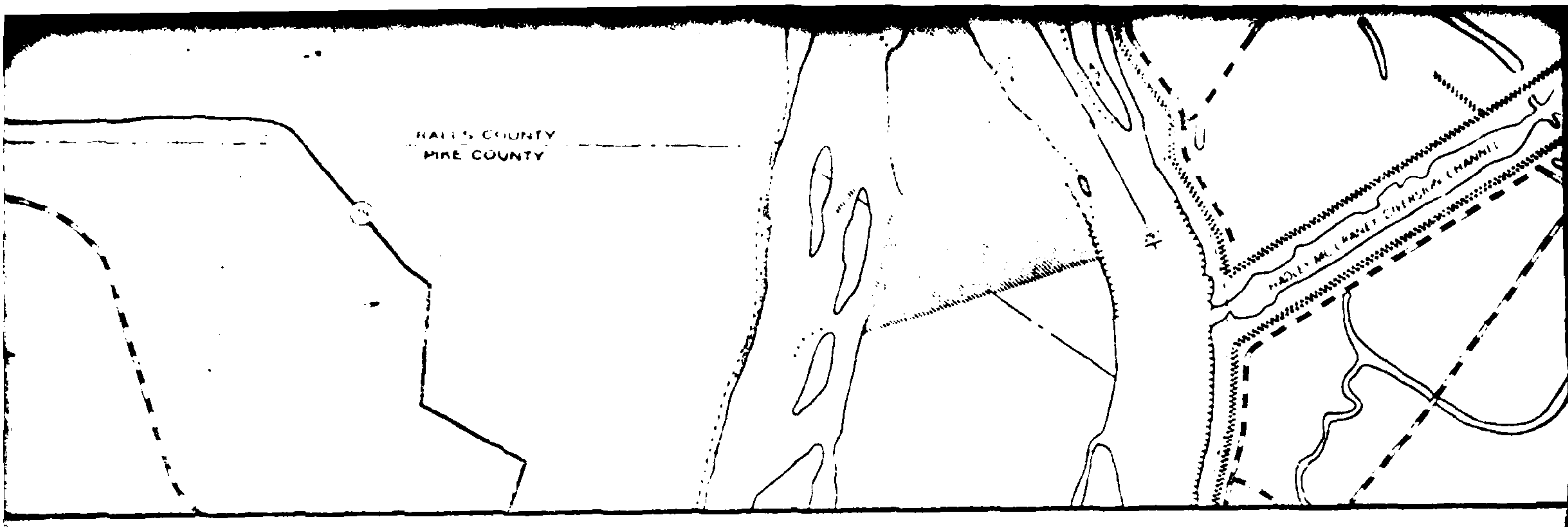
CRITICAL AREA RM 290-291

[illegible]

Future dredge material placement in this critical area will probably consist of the Open Water Placement and Selective Placement methods.

PLATE 12-O


SAVERTON
LOCK AND
DAM NO. 22
COTTEL ISLAND
ILLINOIS
PIKE COUNTY
SNY ISLAND LEVEE DRAINAGE DISTRICT
ROCK ISLAND ENGINEER DISTRICT
ST LOUIS ENGINEER DISTRICT
TAYLOR
ISLAND
BIG CUT
BUFFS ISLAND
MISSOURI
RALLS COUNTY
RALLS COUNTY
PIKE COUNTY
HADLEY MC CRANEY DIVERSION CHANNEL



LEGEND

5-year projected dredge cuts

Placement capability*

* Based on current 950 ft. placement capability of Dredge Kennedy. Plant limitations restrict placement to within 15° of channel and prohibit overbank placement.

STATUTE MILES

0 1 2

Future dredge material placement in this critical area will probably consist of the Open Water Placement and Selective Placement methods.

PLATE 12-P

2